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(पहला पुनरीक्षण)

Design, Installation and Maintenance of Fixed Automatic Sprinkler Fire Extinguishing Systems — Code of Practice

(First Revision)

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Firefighting Sectional Committee had been approved by the Civil Engineering Division Council.

A sprinkler system consists of water supply and one or more sprinkler installations, each installation further consisting of a set of installation control valves and a pipe array fitted with sprinkler heads. The sprinkler heads are fitted at specified locations at the roof or ceiling, and where necessary between racks, below shelves, inside ovens or stoves or below obstructions.

A sprinkler has two functions to perform. It first detects a fire, and then provides an adequate distribution of water to control or extinguish (suppress) it. Each function is performed separately and one is independent of the other except to the extent in so far as early detection makes extinction easier because the fire has not grown large. The classic use of the sprinkler is in the hot gas layer which forms beneath the ceiling of an enclosure in which a fire is developing. Sprinkler protection minimizes not only fire damage, but also non-thermal damage, and allows for quick resumption of operations.

The sprinklers operate at pre-determined temperatures to discharge water over the affected part of the area below, the flow of water through the alarm valve initiating a fire alarm. The operating temperature is generally selected to suit ambient temperature conditions. Sprinklers in the vicinity of the fire, that is, only those which become sufficiently heated, operate. It should not be assumed that the provision of sprinkler system entirely obviates the need for other means of fighting fires and it is important to consider the fire precautions in the premises as a whole.

Structural fire resistance, egress components (that enable escape of occupants from a building), fire alarm systems, particular hazards needing other fire protection methods, provision of hose reels and fire hydrants and portable fire extinguishers, etc, including safe working and good handling methods, management supervision and good housekeeping all needs consideration. It is essential that sprinkler systems should be properly maintained to ensure operation when required. This routine is liable to be overlooked or given insufficient attention by supervisors. It is, however, neglected at peril to the lives of the occupants of the premises and at the risk of financial loss. The importance of proper maintenance cannot be too highly emphasized. When sprinkler systems are disabled, extra attention should be paid to fire precautions and the appropriate authorities informed. This aspect has been discussed in detail in the standard.

This standard has been divided into various clauses and each one deals elaborately with various aspects of the sprinkler protection system. The pipe sizing and hydraulic calculations for various hazards are discussed in detail. The standard also suggests about the location where the system is required and where the systems can be excluded.

This standard was first published in 2002 and provided for pre-calculated systems. Based on the advancements in the field world over, including innovations in the design and installation of automatic fire sprinkler systems, and the experience gained over the years in the country, this first revision of the Indian Standard has been brought out. In this revision, the following major changes have been made:

a) Working of sprinkler systems has been elaborated.
b) Pre-calculated systems have been retained only for small installations of light and ordinary hazard types.
c) Emphasis has been laid on hydraulic calculations for high hazard systems, irrespective of their size, in line with the practices world over.
d) Fire protection requirements using sprinkler systems for high rise buildings have been elaborated.
e) Classification of commodities under storage has been enlarged to accommodate most of the substances which are stored and used in various process industries and also for plastic based products.
f) Pumping capacity and the water requirements for the sprinkler system have been suitably modified based on the innovations in sprinkler design.
g) Innovative types of sprinklers such as early suppression fast response (ESFR) sprinklers and large drop sprinklers, have also been listed and guidance suggested for their specialist application purposes.

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Indian Standard

DESIGN, INSTALLATION AND MAINTENANCE OF FIXED AUTOMATIC SPRINKLER FIRE EXTINGUIGHING SYSTEMS — CODE OF PRACTICE

(First Revision)

1 SCOPE

1.1 This standard specifies minimum requirements for the design, installation and maintenance of fixed automatic sprinkler systems in various types of building occupancies including industrial and storage, and particular requirements for sprinkler systems, which are integral to measures for the protection of life and property.

1.2 This standard covers only the types of sprinkler covered and detailed in **7**.

1.3 The requirements of this standard are also applicable to any addition, extension, repair or other modification to a sprinkler system.

1.4 The requirements of this standard are not applicable to water spray or deluge systems, which are covered in IS 15325 and IS 15519.

1.5 The requirements are not valid for certain specific applications like those on ships, in aircrafts, on vehicles and for below ground systems in the mining industry and the like.

1.6 The water supply and pumping capacity requirements have been already specified in Table 7 under **5.1** of SP 7 (Part 4) for building occupancies namely Group A to Group F and for few occupancies types under Group G, and Group H. The requirements for water supply and pumping capacity specified in **13** and **12** respectively are applicable only to those occupancies that are not specifically covered in Table 7 of SP 7 (Part 4); which are covered in various clauses of this standard. All other requirements (that is, except pumping and water capacities as mentioned above) of this standard are applicable to all the 9 building occupancies given in SP 7 (Part 4).

1.7 Requirements for automatic sprinkler systems (like pumping and water supplies), and design and installation for all the building occupancies have been specified in detail in this standard (*see* **1.6**).

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

3 TERMINOLOGY

For the purpose of this standard, the definitions as in IS 7673, IS 8757 and the following shall apply. The definitions are divided under various headings for better understanding and greater clarity.

3.1 General

3.1.1 *Automatic Sprinkler* — A fire suppression or control device that operates automatically when its heat activated element is heated to its thermal rating or above, allowing water to discharge over a specified area. All sprinkler heads (*see* IS 9972) shall have,

a) a thermal sensing element that responds to heat;
b) an orifice through which water is released under pressure; and
c) a deflector that forms a spray pattern of water over the fire.

3.1.2 *Sprinkler Yoke* — That part of the sprinkler which retains the heat responsive element in load bearing contact with the sprinkler head.

NOTE — Reference is invited to **7.2** where additional details are available for all types of sprinklers.

3.1.3 *Sprinkler System* — An integrated system of underground and overhead piping designed in accordance with good fire engineering practice. The system includes a dedicated water supply that caters to one or more systems. The portion of the system above ground is a network of specially sized or hydraulically designed piping installed in a building to which sprinklers are attached in a systematic pattern. Each system has a control valve that includes a device for actuating an alarm when the system is in operation. The system is actuated by heat from a fire and discharges water over the fire area.

3.1.4 *Sprinkler Characteristics*

a) *Thermal Sensitivity (of Thermal Element)* — A measure of rapidity with which the thermal element operates as installed in a specific sprinkler or sprinkler assembly. One measure of thermal sensitivity is the RTI, that is, response time index as measured under prescribed test conditions. A numerical value that represents the sprinkler's sensitivity to heat and is used to predict the response of a sprinkler in fire environments defined in terms of gas temperature and velocity versus time. It is represented in the following equation:

$$RTI = \tau^* (u)^{0.5}$$

where

τ is time constant of the heat responsive element, and u is the gas velocity.

The thermal element *RTI* for standard response sprinklers is 80 $(\text{m/s})^{0.5}$ or more. The thermal element *RTI* for quick/fast response sprinklers is 50 $(\text{m/s})^{0.5}$ or less.

b) *Temperature rating* — *See* **7.5**.

c) *Orifice size (K-Factor)* — *See* **7.3** and **7.4**.

3.2 Types of Sprinkler Systems

3.2.1 *Wet Pipe Systems* — Sprinkler systems employing automatic sprinklers attached to a piping network always charged with water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire.

3.2.2 *Dry Pipe Systems* — Sprinkler systems employing automatic sprinklers attached to a piping network containing air or nitrogen under pressure, the release from which permits the water pressure to open a valve known as dry pipe valve, and then water flows into the piping network and discharges from the opened sprinklers.

3.2.3 *Deluge System* — Sprinkler systems employing open sprinklers that are attached to a piping network that is connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping network and discharges from all sprinklers connected thereto.

3.2.4 *Pre-action System* — Sprinkler systems employing automatic sprinklers attached to a piping network that contains air or nitrogen that might or might not be under pressure, with a supplemented detection system installed in the same area as the sprinklers. Pre-action system can be combined with either dry or wet pipe system applications.

3.2.5 *Anti-freeze System* — Wet pipe sprinkler systems employing automatic sprinklers attached to a piping network containing anti-freeze solution and that are connected to a water supply. The anti-freeze solution is discharged, followed by water, immediately upon operation of sprinklers opened by heat from a fire.

3.2.6 *High Rise System* — Sprinkler system in which the highest sprinkler is more than 45 m above the lowest sprinkler or above the sprinkler pumps, whichever is the lower.

3.2.7 *Life Safety System* — Sprinkler systems forming an integral part of measures required for the protection of life, especially where evacuating the building depends on the performance of the sprinkler system and sprinklers are required expressly for life safety purposes.

3.3 Type of Sprinklers

The Various types of sprinklers are given below:

3.3.1 *According to the Release Mechanism*

a) *Fusible element sprinklers* — Opened under the influence of heat by melting of a component.

b) *Glass bulb sprinklers* — Opened under the influence of heat by the bursting of glass bulb through pressure resulting from expansion of the fluid enclosed therein.

3.3.2 *According to the Type of Discharge*

a) *Conventional sprinkler* — A sprinkler that has components similar to a standard-spray sprinkler and has a spherical water distribution directed towards the ground over a definite protection area. These sprinklers shall discharge from 40 or more percent of the total water flow initially in an upward direction.

b) *Spray sprinkler* — Induces a paraboloid water distribution directed towards the ground over a definite protection area. These sprinklers shall discharge from 80 or more percent of the total water flow in a downward direction.

3.3.3 *According to the Mounting Pattern*

a) *Pendent sprinkler* (*Non-storage type*) — Sprinkler designed to be installed in such a way that the water stream is directed downward towards the deflector which in turn directs the water downwards toward the protected area. The sprinkler is designed to have the deflector oriented vertically below the pipe to which the sprinkler is connected.

b) *Upright sprinkler* (*Non-storage type*) — Sprinkler designed to be installed in such a way that the water stream is directed upward against the deflector which in turn redirects the water downwards toward the protected area. The sprinkler is designed to have the deflector oriented vertically above the pipe to which the sprinkler is connected.

c) *Sidewall sprinkler* (*Non-storage type*) — Sprinkler having special deflector that are designed to discharge most of the water away from the nearby wall in a pattern resembling one quarter of a sphere, with a small portion of the discharge directed at the wall behind the sprinkler.

d) *Recessed sprinkler* (*Non-storage type*) — Sprinkler in which all or part of the body, other than the shank thread, is mounted within a recessed housing with the plane of the orifice above the plane of the ceiling, or behind the plane of the wall on which the sprinkler is mounted.

e) *Flush sprinkler* (*Non-storage type*) — Sprinkler in which essentially all of the body, other than the shank thread with the exception of the thermal sensing element, is mounted above the lower plane of the ceiling.

f) *Concealed sprinkler* (*Non-storage type*) — A recessed sprinkler with a cover plate.

g) *Sprinkler rosette (Escutcheon)* — Plate covering the gap between the shank or body of a sprinkler projecting through a suspended ceiling and the ceiling, or wall.

3.3.4 *According to Special Applications*

Sprinklers are classified according to their application in specific occupancies. Some parts of the world classify sprinklers as storage and non-storage sprinklers whereas, some other classify them as control mode specific application (CMSA type) sprinklers and control mode density area (CMDA type) sprinklers. At present, previous classifications are being used in this standard (with references to new classifications) and over a period of time, efforts will be made to identify the same with classifications adopted in rest of the world.

a) *Extended coverage (EC) sprinkler* — A sprinkler where the area of coverage exceeds that given for a standard sprinkler based on the occupancy being protected. A sprinkler which extends the usual maximum area of protection at increased spacing and listed as a EC sprinkler.

b) *Extra-large orifice (ELO) sprinkler* — A type of spray sprinkler which discharges at a hemispherical pattern, provide greater flows at lower pressures in comparison to standard or large orifice sprinklers.

c) *Large drop sprinklers* — A type of spray sprinkler that is capable of producing characteristic large water droplets and is listed for its capability to provide fire control of specific high-challenge fire hazard.

d) *Early suppression fast response (ESFR) Sprinklers* — A type of fast response sprinkler that is listed for its capability to provide fire suppression of specific high-challenge fire hazards. Sprinkler that gives a downward parabolic pattern of water discharge with high momentum and mass flow directly below and adjacent to the sprinkler and a diminishing density with increasing distance from the sprinkler.

e) *Intermediate level or rack storage sprinkler* — A sprinkler that is installed within a storage rack. A sprinkler equipped with integral shields to protect its operating elements from the discharge of the sprinklers installed at higher elevations. These sprinklers are typically K-5.6 (K-80), K-8.0 (K-115) or K-11.2 (K-160) non-storage ones equipped with an attached water shield over the top of the thermal sensing element. The water shield prevents wetting of the thermal sensing element by water from sprinklers at a higher elevation in the rack or at ceiling level.

f) *Cut-off or open sprinkler* — A sprinkler protecting a door or window between two areas only one of which is protected by the sprinkler.

g) *Window sprinklers* — Sprinklers specifically listed to provide appropriate fire rating for heat strengthened or tempered glass windows using closed sprinklers.

3.3.5 *According to Occupancies*

a) *Storage automatic sprinkler* — A closed head sprinkler with a nominal K-factor of 160 or larger having either a fast response or a standard response element and designated as 'storage sprinkler'. These sprinklers protect storage-type occupancies and/or any other high heat release type fires.

b) *Non-storage type sprinklers* — A sprinkler which protect non-storage type occupancies and or any other low to moderate heat release type fires such as manufacturing occupancies.

3.4 Alarm Valve

3.4.1 *Water Flow Alarm Device* — A device that is installed on a sprinkler system that detects a water flow when one or more sprinklers operate and provide alarm. It is connected to a fire alarm system to further initiate an alarm condition or is used electrically to initiate a fire pump or local audible or visual alarm.

3.4.2 *Alarm Test Valve* — A valve through which water may be drawn to test the operation of the water motor fire alarm and/or of any associated electric fire alarm.

3.4.3 *Alarm Check Valve* — A check valve, of the wet, dry or composite type, which is specifically designed to allow a means of alarm notification when water flows through it. Each type of sprinkler systems mentioned in **3.2** have alarm check valves connected thereto.

3.5 Piping (*See* Fig. 1 *and* Fig. 2)

3.5.1 *Trunk Mains* — A pipe connection to two or more water supply pipes to the installation main control valve set(s).

3.5.2 *Supply Pipe* — A pipe connecting a water supply to a trunk main or the installation main control valve set(s), or a pipe supplying water to a private reservoir, suction tank or gravity tank.

3.5.3 *Main Distribution Pipe (Feed Main)* — A pipe feeding a distribution pipe or more distribution pipes.

3.5.4 *Distribution Pipe (Cross Main)* — Pipes supplying the branch lines, either directly or through riser nipples (sub-distribution pipe). The piping network of a tree-type sprinkler system that provides water to the branch lines. A pipe feeding either a range pipe directly or a single sprinkler on a non-terminal range pipe more than 300 mm long. Distribution pipe from a main distribution pipe, to a terminal branched pipe array (distribution pipe spur).

3.5.5 *Range (or Branch) Pipe* — A pipe feeding sprinkler directly or *via* arm pipes of restricted length.

3.5.6 *Arm Pipe* — A pipe less than 300 mm long, other than the last section of a range pipe, feeding a single sprinkler.

3.5.7 *Riser* — A vertical pipe feeding a distribution or range pipe.

3.5.8 *Drop* — A vertical pipe feeding a distribution or range pipe.

3.5.9 *Terminal Range Configuration* — A pipe array with only one water supply route from a distribution pipe.

3.5.10 *Terminal Main Configuration* — A pipe array with only one water supply route to each range pipe.

3.5.11 *System Riser* — The above ground horizontal or vertical pipe between the water supply and the mains that contain a control valve and water flow alarm device.

3.5.12 *Pipe Array* — Pipes feeding a group of sprinklers. Pipe arrays can be looped, gridded or branched.

3.5.13 *End-centre Array* — Pipe array with range pipes on both sides of a distribution pipe.

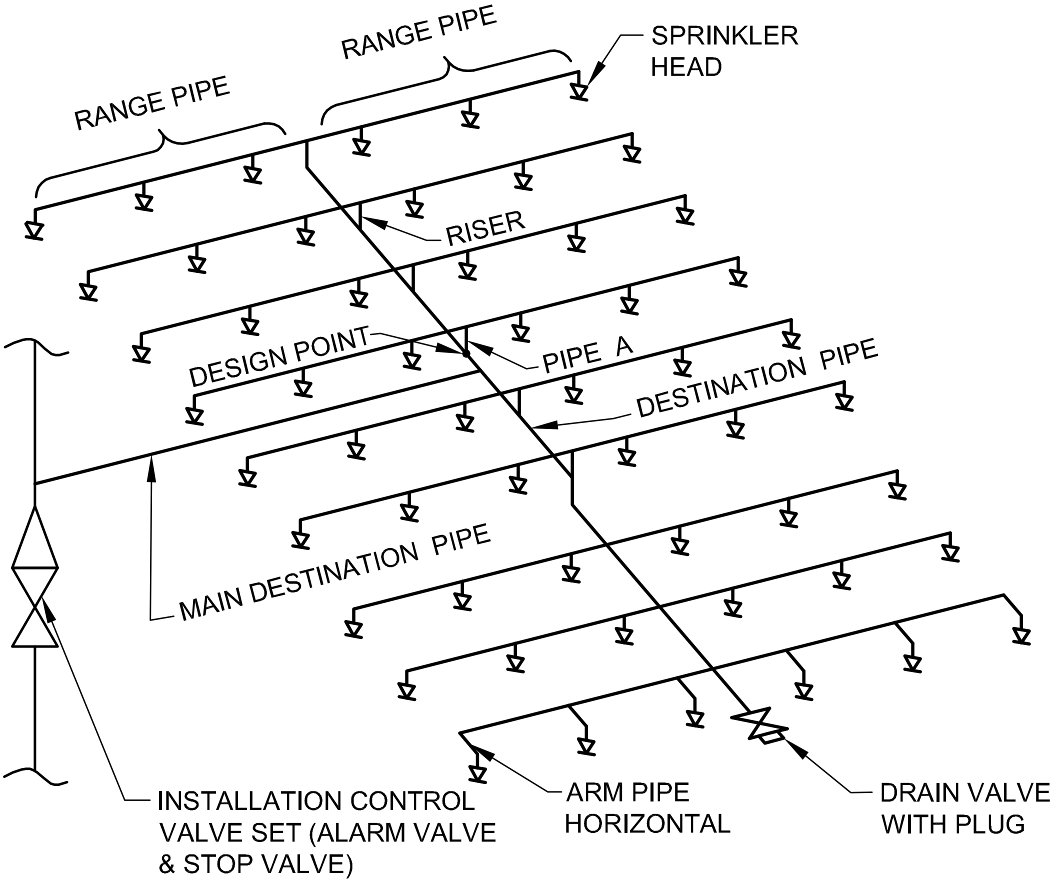
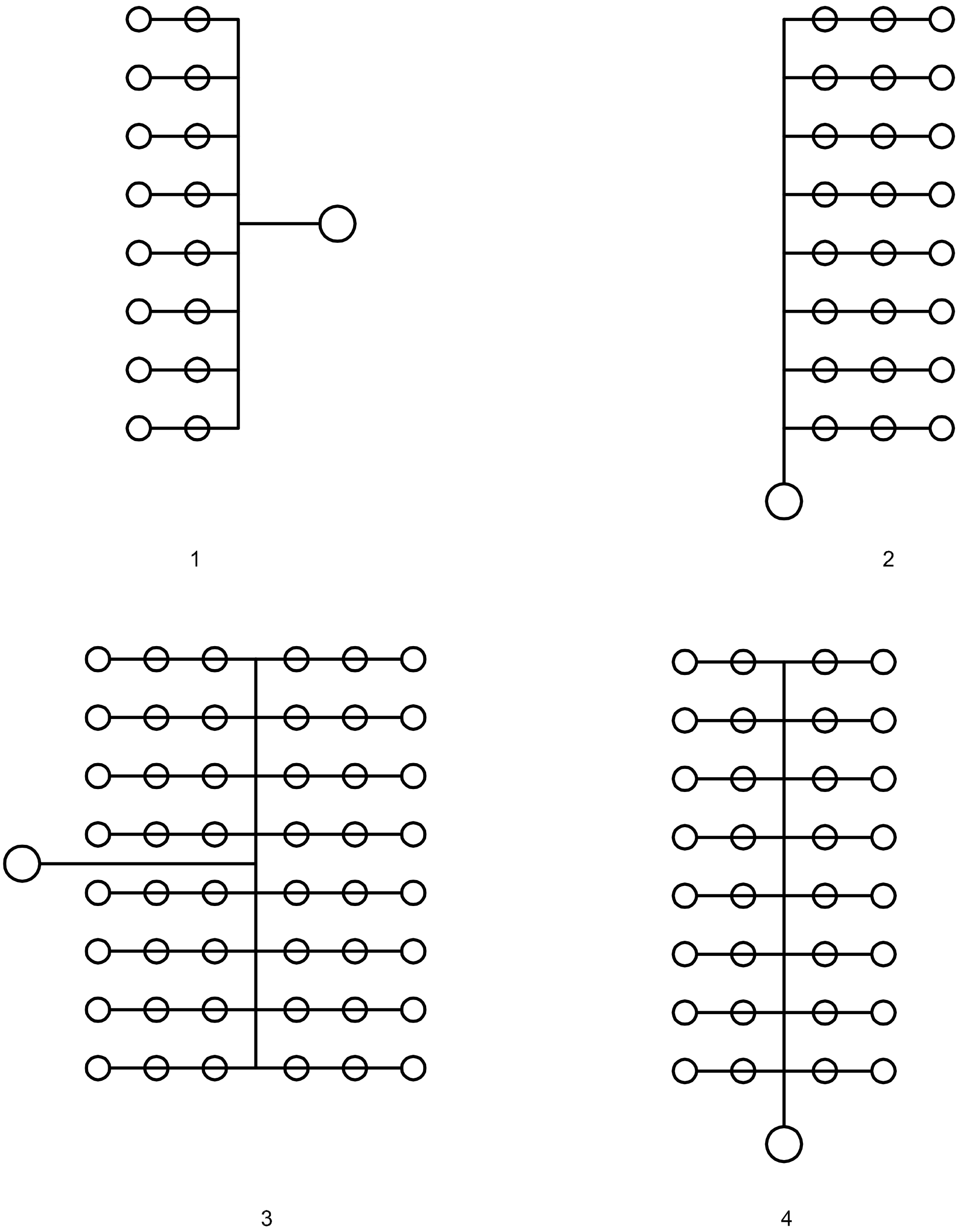


FIG. 1 MAIN ELEMENTS OF A SPRINKLER INSTALLATION



KEY

1 2-END-SIDE ARRAY, WITH CENTRAL FEED
2 3-END-SIDE ARRAY, WITH END FEED
3 3-END-CENTRE ARRAY, WITH CENTRAL FEED
4 2-END-CENTRE ARRAY, WITH END FEED

Fig. 2 Range Pipe Arrays in Group of Sprinklers

3.5.14 *End-side Array* — Pipe array with range pipes on one side only of a distribution pipe.

3.5.15 *Zone* — Sub-division of an installation with a specific flow alarm and fitted with a monitored subsidiary stop.

3.6 Hydraulics of the System

3.6.1 *Hydraulically Designed System* — A calculated sprinkler system in which pipe sizes are selected on a pressure loss basis to provide a prescribed water density, in lpm/m^2, or a prescribed minimum discharge pressure or flow per sprinkler, distributed with a reasonable degree of uniformity over a prescribed area.

3.6.2 *Fully Hydraulically Calculated* — A term applied to pipe work sized as specified in **10.5** or an installation in which all the pipe work downstream of the main installation control valve set is sized.

3.6.3 *Assumed Maximum Area of Operation (Hydraulically Most Favourable Location)* — The location in a sprinkler array of an AMAO of specified shape at which the water flow is the maximum for a specific pressure.

3.6.4 *Assumed Maximum Area of Operation*, *Hydraulically Most Unfavourable Location* — The location in a sprinkler array of an AMAO of specified shape at which the water supply pressure is the maximum needed to give the specified design density.

3.6.5 *Design or Demand Area* — The design or demand area is a theoretical area of the sprinkler operation within a protected building in m^2, representing the worst case area where a fire could burn.

3.6.6 *Design Density* — The design density is a measurement of how much litres of water per square metre of floor area (lpm/m^2) should be applied to the design area. The minimum density of discharge, in mm/min of water, for which a sprinkler installation is designed, determined from the discharge of a specified group of sprinklers, in lpm, divided by the area covered, in m^2.

3.6.7 *Pre-calculated* — A term applied to pipework sized as specified in **10.4** or an installation in which pipe downstream of the design point is sized by calculations.

NOTE — This term is only for the extension of old pre-calculated systems. All new systems shall be fully calculated, *see* **10.3.1**(b).

3.6.8 *Design Point* — Point on a distribution pipe of a *pre-calculated* installation, downstream of which pipework is sized from tables and upstream of which pipework is sized by hydraulic calculation (*see also* Fig. 11 and Fig. 12).

3.6.9 *'A' Gauge* — Pressure gauge connected to a town main connection, between the supply pipe stop valve and the non-return valve.

3.6.10 *'B' Gauge* — Pressure gauge connected to and on the same level as an alarm valve, indicating the pressure on the upstream side of the valve.

3.6.11 *'C' Gauge* — Pressure gauge connected to and on the same level as an alarm valve, indicating the pressure on the downstream side of the valve.

3.7 Layouts

3.7.1 *Standard Sprinkler Layout* — A rectilinear lay out with the sprinkler aligned perpendicular to the run of the ranges (*see* Fig. 3A).

3.7.2 *Staggered Sprinkler Layout* — An off-set lay out with the sprinklers displaced one half pitch along the range or branch pipe relative to the next range or ranges (*see* Fig. 3B).

3.7.3 *Looped Layout* – Sprinkler system in which multiple cross mains are tied together so as to provide more than one path for water to flow to an operating sprinkler and branch lines are not tied together (*see* Fig. 3C).

3.7.4 *Gridded Layout* — Sprinkler systems in which parallel cross mains are connected by multiple branch lines. An operating sprinkler will receive water from both ends of its branch line, while the other branch lines help transfer water between cross mains (*see* Fig. 3D).

3.8 Building

3.8.1 *Ceiling Height* — Distance between the floor and underside of the ceiling above.

3.8.2 *Flat Ceiling* — A continuous ceiling in a single plane.

3.8.3 *Horizontal Ceiling* — A ceiling with a slope not exceeding 1 in 6 (9°).

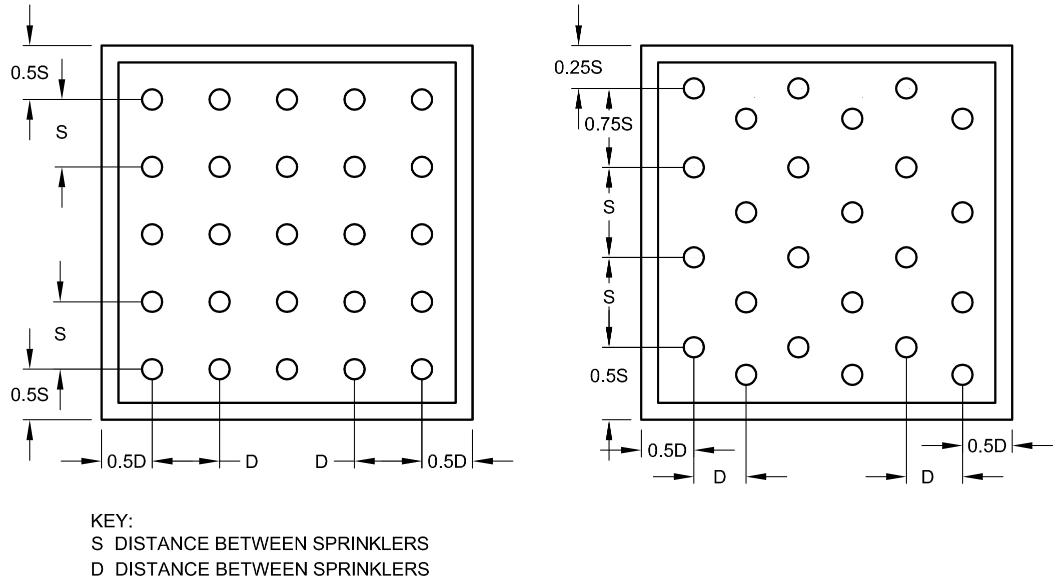
3.8.4 *Sloped Ceiling* — A ceiling with a slope exceeding 1 in 6 (9°).

3.8.5 *Smooth Ceiling* — A continuous ceiling free from significant irregularities, lumps or indentations.

3.8.6 *Compartment* — A space completely enclosed by walls and ceiling.

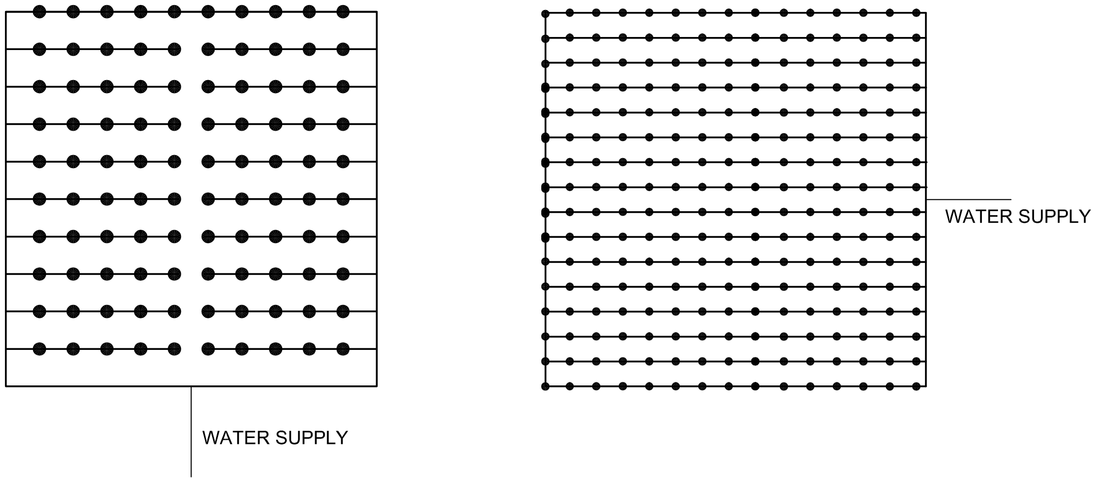
3.8.7 *Drop-out Ceiling* — A suspended ceiling system which is installed below the sprinklers.

3.8.8 *Obstructed Construction* — Panel construction and other construction where beams, trusses and other building members impede the heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire.



3A RECTANGULAR MATRIX

3B STAGGERED LAYOUT



3C LOOPED LAYOUT

3D GRIDDED LAYOUT

Fig. 3 Sprinkler Network Layout

3.8.9 *Unobstructed Construction* — Construction where beams, trusses and other building members do not impede the heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire.

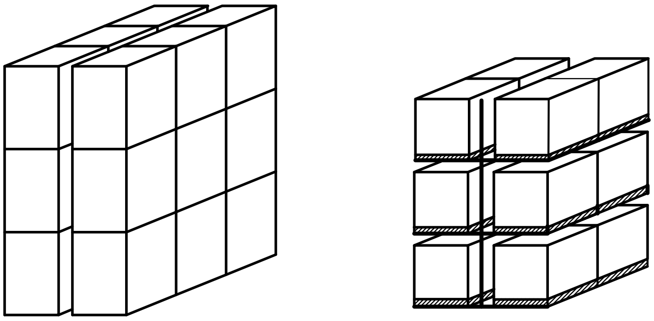
3.9 Storage (*See* Fig. 4)

3.9.1 *Bin Box Storage* — A storage arrangement that typically consists of solid shelves vertically located no more than 900 mm apart in combination with solid full height wooden or metal vertical barriers that are horizontally located no more than 1 200 mm apart.

3.9.2 *Cartoned Storage* — A method of storage consisting of corrugated cardboard or paperboard containers fully enclosing the commodity.

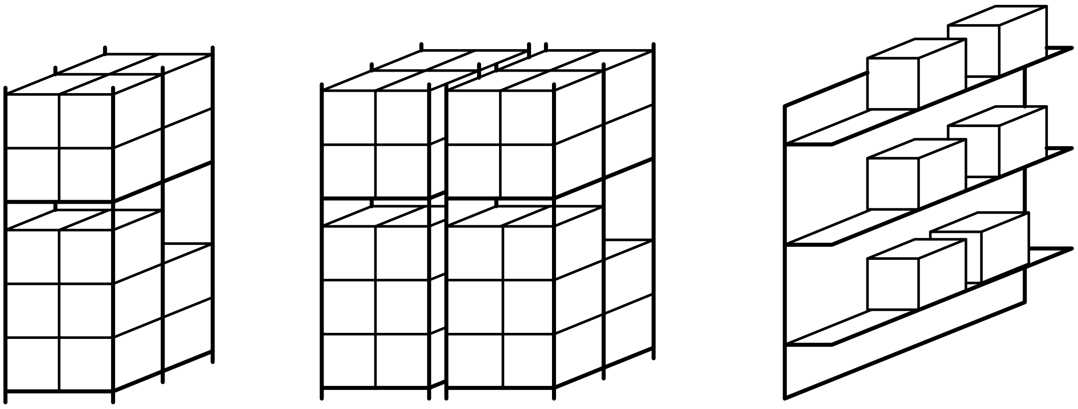
3.9.3 *Clearance Storage* — The distance from the top of the storage to the deflectors of ceiling sprinklers above.

3.9.4 *Exposed Plastic Commodities Storage* — Those plastics not in packaging or coverings that absorb water or otherwise appreciably retard the burning hazard of the commodity.



4A FREE- STANDING OR
BLOCK STACKING STORAGE (ST 1)

4B PALLETIZED RACK
(BEAM PALLET RACKING) (ST 4)



4C POST- PALLET STORAGE
IN SINGLE ROW (ST 2)

4D POST- PALLET STORAGE
IN MULTIPLE ROWS (ST 3)

4E SOLID OR SLATTED SHELVES (ST 5)

Fig. 4 Storage Illustration

3.9.5 *Flue Space* — The spaces between rows of storage. Flue spaces that are less than a net 75 mm wide are not considered flue spaces for fire protection purposes. In addition, any space between rows of storage that exceeds 600 mm horizontally is considered an aisle for fire protection design purposes.

a) *Longitudinal* — The space between rows of storage perpendicular to the direction of loading with a width not exceeding 600 mm between storage.

b) *Transverse* — The space between rows of storage parallel to the direction of loading.

3.9.6 *High Piled Storage* — Solid piled, freestanding, palletized, rack storage and shelved storage where the height exceeds 4 m.

3.9.7 *Open Top Containers* — These are containers having at least one side and open on top. Containers that have five sides will collect and hold up water that has been discharged from operating ceiling-level sprinklers thus delaying the water delivery down through the flue spaces where it is needed to either suppress or control the fire.

3.9.8 *Palletized Storage* — A storage arrangement whereof commodities are stored on pallets. Pallet loads are placed one on top of another with the bottom load located directly on the floor.

3.9.9 *Rack* — Any combination of vertical, horizontal and diagonal structural members that support stored materials or commodities.

a) Storage in racks that use combinations of vertical, horizontal and diagonal members, with or without solid shelves, to support stored material. Racks may be fixed-in-place or portable. Loading may be either conducted manually by using lift trucks, stacker cranes, or hand placement, or automatically by using machine-controlled storage and retrieval systems.

b) Single-row racks have no longitudinal flue spaces, are up to 1.8 m deep and double-row racks are two single-row racks placed back-to-back separated by a longitudinal flue space, have aisles over 0.6 m wide.

c) Multiple-row racks are racks greater than 3.6 m wide, or single-row or double-row racks separated by aisles 0.6 m wide or less having an overall width, including flues, greater than 3.6 m. Multiple-row racks can be drive-in, drive-through, flow-through, push-back or double-deep standard racks. The rack depth is the determinant.

3.9.10 *Shelf Storage* — Storage on structures up to and including 750 mm in depth and separated by aisles at least 750 mm wide.

3.9.11 *Solid Piled Storage* — On-floor storage, without pallets or other material handling devices. Storage of commodities stacked one over the other leaving no horizontal spaces between unit loads.

3.9.12 *Slatted Shelf Rack* — A rack where shelves are fixed in place with a series of narrow individual solid supports used as the shelf material and spaced apart with regular openings.

3.9.13 *Solid Shelf Rack* — A rack where shelves are fixed in place with a solid, slatted or wire mesh barrier used as the shelf material and having limited or no openings (less than 70 percent open), in the shelf area. Solid shelving within storage racks can promote horizontal fire spread and negatively impact the amount of sprinkler water that can reach the entire vertical height of the rack.

The area of a solid shelf is defined by minimum net clear flue space width of 75 mm at all four edges of the shelf. A net clear flue space width is the gross width of the flue space minus the width of any obstruction (such as a rack upright).

NOTE — For example, 125 mm flues that have 50 mm wide horizontal rack members within the space would be acceptable because the net flue space width is 75 mm.

3.9.14 *Unexpanded Plastics* — Unexpanded plastics are high-density materials that may be blown into different shapes such as drums, containers, electronics housings, etc.

4 REQUIREMENTS REGARDING DOCUMENTATION

4.1 Drawings shall be drawn up in accordance with the following requirements, *see also* IS 962. Where acceptable to the approving authorities, digital copies of drawings are also permissible.

a) Drawings shall be clear, contain all required details including scale and point of compass and shall be dated.

b) Drawings of new installation shall show the entire compound; all buildings therein, with their door and window openings, and the boundary walls. Buildings under construction and future extension envisaged shall be indicated by the dotted lines.

c) Drawings of extensions to approved existing installations need not show the rest of the compound but sufficient details shall be given of the existing installations in correlation to the extension, to enable the authorities concerned to check the plans and offer comments.

d) In case of storied buildings, drawings submitted shall include plans of each storey together with sectional elevations.

e) Drawings shall be on white paper or ammonia paper or ferro prussiate paper.

f) Drawings shall generally be prepared in accordance with SP 46, shall not exceed 850 × 1200 mm in size and shall be drawn to a scale of 1 : 500 or 1 : 1 000. In the case of very large compounds with more than one building, it is advisable to submit separate drawing for each risk with a key plan showing the relative situation of the various buildings, etc, in the compound.

4.2 Drawings shall also depict the following details with illustration:

a) *Pucca* walls to be shown by double lines, doors and windows being clearly marked.
b) Iron or other non-masonry walls to be shown by a thin line and nature of construction indicated.
c) Fire walls to be indicated by the sign 'FIRE WALL' at each end of the wall alongside or across them at regular intervals and marked in distinctive colours.
d) Fire doors and/or shutters (*see* IS 3614) to be marked as follows:
    1) Single fire door and/or shutter – 'SFD'; and
    2) Double fire door and/or shutter – 'DFD'.
e) Skylights to be marked 'Sky Lights' or 'SL'.
f) Boiler to be shown by a rectangular figure marked 'BOILER'.
g) Sprinkler mains to be shown by a blue line; the diameter, length and number of pipes being marked alongside and specials and reducers to be clearly indicated as ' ___ mm, diameter, lengths of __ metre each'.
h) Sprinkler pumps to be clearly marked and the capacity and head to be indicated in each case.
j) Pump(s) suction piping to be shown dotted and diameter to be indicated.
k) Fire service water tanks and reservoirs to be shown to scale.
m) Sprinkler trunk mains to be shown by a blue line, the sizes being marked alongside.
n) Fire alarm bells to be shown by a blue line, the sizes being marked 'F. A. B'.
p) Sprinklered blocks to be marked 'S'.
q) Electric cable(s) for the fire pump(s) to be shown in green line(s).
r) Material specifications of equipment and components of the installation, indicating the name of manufacturers and the Indian Standard specifications, if any.
s) In the case of internal appliances, details of the areas of the various compartments, their occupation and the quantities and types of appliances proposed.
t) In the case of sprinkler and hydrant (*see* IS 908) installations, fully dimensioned plans in duplicate shall be submitted.

4.3 In addition to the above, the following details would be necessary in the case of sprinkler installation:

a) Drawings showing layout of the entire sprinkler system, incorporating material specifications, different sizes of mains, etc.
b) In case of storied blocks, floor area of each floor showing particulars. Separate sprinkler layout drawing shall be submitted for each floor.
c) Each sprinkler layout drawing shall indicate the details of sprinklers used like number of sprinklers, type, temperature rating, K-factor and sprinkler identification number, etc.
d) Number of sprinklers on each installation control valve set.
e) Height of highest sprinkler on each installation control valve set; the type(s) of installation(s) and the nominal diameter(s) of the main control valves.
f) Number or reference of each installation main control valve set and its accessibility.
g) Layout of pump house showing clearly the suction, delivery and priming (if any) and freeboard arrangements.
h) Details of water storage tanks giving particulars of compartmentation and common sump, details of inflow and levels for tappings for suction, inflow, overflow and free board levels.
j) Substation location in relation to other blocks if the pump is electrically driven.
k) Route of cable from substation to fire pump house.
m) Schematic circuit line diagram showing electric feed to fire pump.
n) A statement that the system will comply with this specification including details of any deviations from its recommendations with the reasons for the deviations.
p) A list of the components suitable for sprinkler use, included in the system each identified by manufacturer's name and model/reference number.
q) Hydraulic calculations to show that system is fully balanced particularly if in-rack automatic sprinkler system is provided.

4.4 Installation Layout Drawings

4.4.1 *General*

The scale shall be not less than 1 : 100. Layout drawing shall include the following information:

a) North point indication.
b) The class or classes of installation according to hazard class including stock category and design storage height.

c) Constructional details of floors, ceiling, roofs and exterior walls and walls separating sprinklered and non-sprinklered areas.
d) Sectional elevations of each floor of each building showing the distance of sprinklered from ceiling, structural features, etc which affect the sprinkler layout or the water distribution from the sprinklers.
e) The location and size of concealed roof or ceiling voids, offices and other enclosures sealed at a level lower than the roof of ceiling proper.
f) Indication of trunking, staging, platforms, machinery, fluorescent light fittings, heaters, suspended open cell ceilings, etc, which may adversely affect the sprinkler distribution.
g) The sprinkler types(s) and temperature ratings(s).
h) The location and type of main control valves and location of alarm motors and gongs.
j) The location and details of any water flow and air or water pressure, alarm switches.
k) The location and size of any tail-end air valves, subsidiary stop valves and drain valves.
m) The drainage slope of the pipework.
n) The location and specification of any orifice plate.
p) A schedule listing the numbers of sprinklers, medium and high-velocity sprayers, etc and the area of protection.
q) A key to the symbols used.

4.4.2 *Pre-calculated Pipework*

For pre-calculated pipework the following details shall be given on, or with, the drawings:

a) Identification of the design points of each array on the layout drawing.
b) A summary of the pressure losses between the control valve and the design points at the following design rates or flow:

In a light-hazard installation : 225 litre/min

In an ordinary-hazard installation : 1 000 litre/min

In a high hazard installation : The flow corresponding to the appropriate design density

NOTES

1 Pre-calculated pipework is applicable only to the extensions of old systems with such pipework. [Pre-calculated pipework is only for the extension of old pre-calculated systems, *see* **10.3.1**(a)].

2 For light and ordinary-hazard installations with pre-calculated pipe work, the pressure needed at the design point is not specified. Instead the friction loss in the pipe work between the control valve and the design points is limited to a predetermined value, incorporated in the value specified for pressure at the control valves. Static head is added to this pressure to give the value defining the minimum actual water supply running pressure.

4.4.3 *Hydraulically Calculated Pipe Work*

For hydraulically calculated pipe work, the following shall be given, with detailed calculations, either as purpose designed work sheets or as a computer print-out:

a) *For each design area of operation*:
    1) Area identification.
    2) Hazard class.
    3) Specified density of discharge (in mm/min).
    4) Assumed area of maximum operation (AMAO) (in m^2).
    5) Number of sprinklers in the AMAO.
    6) Maximum area covered per sprinkler (in m^2).
    7) Detailed and dimensioned working drawings showing the following:
        i) Node or pipe reference scheme used to identify pipes, junctions, sprinkler heads and fittings which need hydraulic consideration.
        ii) Position of the hydraulically most favourable AMAO.
        iii) Position of the hydraulically most unfavourable AMAO.
        iv) Number of sprinklers upon which the design density is based.
        v) Height above datum of each point of identified pressure value.
b) *For each operating sprinkler*:
    1) Sprinkler node or reference number.
    2) Sprinkler nominal K-factor.
    3) Flow through the sprinkler (in l/min).
    4) Inlet pressure to the sprinkler or sprinkler assembly (in bar).
c) *For each hydraulically significant pipe*;
    1) Pipe node or other reference.
    2) Pipe nominal bore (in mm).
    3) Hazen-Williams constant (c or K-factor) for the pipe.
    4) Flow through pipe (in l/min).
    5) Nominal fluid velocity (in m/s).
    6) Length of pipe (in m).
    7) Numbers, types and equivalent lengths of fittings.
    8) Static head change in pipe (in m).
    9) Pressures at inlet and outlet of pipe in bar.
    10) Friction loss in pipe (in bar).

11) Indication of flow direction.

NOTE — A line diagram of the pipe layout should be prepared showing the following:

- i) Node or pipe reference numbers.
- ii) Distribution pipes.
- iii) Range pipes.
- iv) Sprinkler heads under consideration.
- v) Four hydraulically most unfavorably placed heads.
- vi) Flow through, and pressure at the end of each hydraulically significant pipe.

4.5 Water Supply Drawings

The drawings shall show water supplies and pipework therefrom up to the installation control valves. The drawings shall be on an indicated scale of not less than 1 : 100. A key to the symbols shall be included. The position and type of stop and check valves and any pressure reducing valve, water meter, water lock, orifice plate and any connection supplying water for other services shall be indicated.

4.6 Hydraulic Calculation

4.6.1 *Pre-calculated Installations*

An hydraulic calculation (with relevant flow tests) shall show that each trunk main together with any branch main, from each water supply to a main installation control valve set, water supply test and drain valve and control valve 'C' gauge (that is, including the installation control valves) is capable of providing the required pressure and flow at the installation control valve test and drain valve.

NOTE — Pre-calculated pipework is applicable only to the extensions of old systems with such pipework. [This term is only for the extension of old pre-calculated systems, *see* **10.3.1**(b)].

4.6.2 *Fully Hydraulically Calculated Installations*

Where the pipe work is fully hydraulically calculated the following additional details shall be given:

a) A modified pressure-flow characteristic graph indicating the usable pressure at any flow up to the maximum installation demand.

b) Demand pressure-flow characteristic graph for each installation for the hydraulically most unfavourable (and if required, the most favourable) AMAO with pressure taken as at the control valve 'C' pressure gauge.

5 CLASSIFICATION OF OCCUPANCIES

5.1 General

As the water supply, pumping capacity and other features of the sprinkler installations depends not only on the size of the risk, but also on its fire growth and spread potentialities, the risks are to be categorized under the following classes for the purpose of design of the installation:

a) Light hazard class,

b) Ordinary (or Moderate) hazard class,

c) High hazard class, and

d) Storage hazards.

5.2 Light Hazard

5.2.1 Light hazard occupancies shall be understood as those with low fire loads and with materials within having low rates of heat release. Light hazard occupancies are of non-industrial type.

5.2.2 No single compartment greater than 126 m^2 are allowable within light hazard occupancies and such compartments shall be fire separated by walls having 30 min rating and doors.

NOTE — Otherwise the sprinkler system shall be designed as per ordinary hazard occupancy.

5.3 Ordinary (Moderate) Hazard

5.3.1 Occupancies where combustible materials with a medium fire load and medium combustibility are processed or manufactured.

5.3.2 Also those occupancies not complying with **5.2.2** shall be treated as moderate hazard occupancy.

5.3.3 Materials may be stored in moderate hazard occupancies but the same shall be governed by **8.1.2**(b).

5.4 High Hazard

5.4.1 High hazard, process, covers occupancies where the materials concerned have a high fire load and high combustibility and are capable of developing a quickly spreading or intense fire.

5.4.2 Certain high hazard occupancies shall need to be protected by water spray systems and attention is drawn to IS 15325 in this regard.

5.5 Storage Hazards

5.5.1 High hazard storage covers the storage of goods where the height of storage exceeds the height limits given in **8.1.2**. The overall fire hazard of stored goods is a function of the combustibility of the materials being stored, including their packaging, and of the storage configuration.

5.5.2 Commodities are also categorized under four headings and sprinkler protection requires to be designed according to the category.

5.6 List of Occupancies under Different Classes

The list provided hereunder under each class is not very exhaustive. For categorization of any risk not listed, reference to the authorities concerned with full particulars is essential prior to the design of the installation.

5.6.1 *Light Hazard Occupancies* [*see* **5.2.2**]

Places of worship having assembly (like temples, churches), educational institutions, hospitals (excluding kitchens, stores, utilities), hotels (excluding kitchens, stores, utilities), libraries, museums, nursing homes, office buildings (excluding store rooms), prisons, residential and apartments [*see* **5.2.2** and **11.8.2.7**].

5.6.2 *Ordinary Hazard Occupancies* [*see* **5.3.2**]

Such occupancies apart from others, also includes manufacturing units as listed below:

1. Abattoirs
2. Abrasive wheel and powder
3. Aircraft factories (excluding hangers)
4. Airport terminal buildings
5. Bakeries
6. Biscuit factories
7. Book-binders and publishers
8. Breweries
9. Boot and shoe units
10. Cables
11. Candles
12. Cardboard factories
13. Carpentry and furniture [not involving foam/foam plastics]
14. Carpets
15. Car parking areas within building or basement
16. Cement factories
17. Ceramics factories
18. Chemicals
19. Cinematographic and TV production broadcasting studios
20. Cloth processors
21. Confectioneries
22. Dairies
23. Dehydrated vegetable factories
24. Departmental stores/retail shops
25. Electronic equipment and assembly
26. Engineering workshops
27. Fibreboard factories
28. Flax, jute and hemp mills
29. Flour mills
30. Food and beverages
31. Glass factories
32. Hosiery and garment
33. Jewellery
34. Laboratories
35. Metro stations and associated occupancies within there of
36. Motor garages
37. Paint shops
38. Paper mills
39. Photographic film factories
40. Plywood factories
41. Printing presses
42. Restaurants and cafes
43. Rope factories
44. Rubber and plastics (other than foam plastics)
45. Shopping malls and multiplex occupancies
46. Soap factories
47. Sugar mills
48. Synthetic fibres/yarn factories
49. Tanneries
50. Textile mills
51. Timber and wood-working (except saw mills)
52. Theatres
53. Tobacco factories
54. Wood wool
55. Woolen mills
56. Vermicelli
57. Wax factories

5.6.3 *High Hazard Occupancies*

Occupancies housing or manufacturing (as the case may be) the following:

1. Aircraft hangers
2. Bitumen and wax coated paper
3. Celluloid goods cellulose nitrate
4. Cigarette filter
5. Distilleries
6. Duplicating/stencil paper explosives
7. Fire works
8. Floor cloth and linoleum
9. Foam plastics and foam rubber
10. Hessian cloth/tar felt
11. Match factories
12. Oil mills
13. Paint, colour and varnish factories
14. Resin, rosin, turpentine and lamp black
15. Rubber substitutes making units
16. Saw mills
17. Surgical cotton, mattress and pillow makers
18. Tar distillation units
19. Wood wool manufacturers

5.7 Storage Occupancies

Storage risks (stacked, high-piled or racked) are categorized under four classes as per classifications below. The list is not very exhaustive; and for materials other than what is stated, specialist literature may be referred.

a) Category-I

   1. Adhesive (non-flammable)
   2. Alcohol ≤ 20 percent by volume in glass or plastic bottles
   3. Beer
   4. Bottles – Glass and plastic containing non-flammable liquids
   5. Cement – bagged
   6. Ceramics
   7. Coffee – packaged, cartoned
   8. Crockery
   9. Electrical and mechanical appliances – Metallic
   10. Fertilizers – Phosphate based
   11. Foods, tinned in cardboard boxes and trays
   12. Foods, tinned wrapped in unexpanded plastic film
   13. Footwear other than plastic
   14. Glass fibre
   15. Glassware
   16. Grain in sacks
   17. Groceries
   18. Hardware items
   19. Meat-chilled or frozen
   20. Metal goods
   21. Paints water based
   22. Paper sheets stored horizontally
   23. Wine

b) Category-II

   1. Alcohol > 20 percent by volume in glass bottles
   2. Asphalt paper in horizontal rolls
   3. Batteries, dry cell
   4. Batteries, wet cell
   5. Beer containers in plastic or wooden crates
   6. Books
   7. Cardboard (all types) – Stored flat
   8. Cardboard, except corrugated rolls stored horizontally
   9. Cardboard cartons – Empty light weight boxes
   10. Carpets without foam backing
   11. Cartons, waxed (flats)
   12. Cellulose baled (not cellulose nitrate or cellulose acetate)
   13. Cellulose pulp
   14. Cereals boxed
   15. Charcoal excluding impregnated charcoal
   16. Cheese – packaged, cartoned
   17. Chewing gum – packaged, cartoned
   18. Chocolates – packaged, cartoned
   19. Cloth, wool or cotton
   20. Cocoa products – packaged, cartoned
   21. Coconut matting
   22. Cork and cork-baled
   23. Cotton – baled
   24. Electrical cable or wire
   25. Fertilizer – nitrate based
   26. Fibreboard
   27. Flammable liquids in non-combustible containers
   28. Flax
   29. Flour in sacks or paper bags
   30. Foodstuffs (in sacks, frozen, packaged)
   31. Footware – plastic
   32. Furniture, upholstered with natural fibres and materials but excluding plastics
   33. Furniture, wooden
   34. Furs – flat in boxes
   35. Grain In sacks
   36. Hemp
   37. Hides
   38. Jute
   39. Knitware
   40. Laminated board
   41. Leather goods
   42. Linen
   43. Mattresses other than expanded plastic
   44. Milk powder in bags or sacks
   45. Pallets, plastic or wood
   46. Paper (sheets stored vertically)
   47. Paper (like newspaper), rolls stored horizontally
   48. Paper, pulp – Rolled or baled
   49. Paper waste – Baled
   50. Pharmaceuticals – Glass bottles

51. Photographic films
52. Plastics (non-foamed, other than cellulose nitrate)
53. Pillows feathers or down
54. Rags loose or baled
55. Roof felt in rolls horizontal storage
56. Rope – natural or synthetic fibre
57. Soap, water soluble
58. Spiritous liquors cased glass bottles
59. String – natural or synthetic fibre
60. Sugar in bags or sacks
61. Textiles
62. Timber, sawn (not in ventilated stacks)
63. Timber, unsawn
64. Tobacco – Leaf and finished goods
65. Vegetable fibres – hay, straw, hemp, cotton, etc
66. Wood
67. Wood, chipboard, plywood stored flat, not in ventilated stacks
68. Wood pulp Baled

c) Category – III

1. Adhesive (flammable)
2. Alcohol > 20 percent by volume in plastic bottles
3. Asphalt paper in vertical rolls
4. Butter – Whipped and spread
5. Candles
6. Candy – packaged and cartoned
7. Canvas, tar impregnated
8. Carbon black
9. Cardboard, except corrugated rolls stored vertically
10. Cardboard, corrugated rolls stored horizontally
11. Cardboard cartons empty heavy weight made up boxes
12. Carpet tiles
13. Carpets with foam backing
14. Cartons, waxed (made up)
15. Cloth, synthetic
16. Electrical and mechanical appliances – other than metallic
17. Esparto – loose or baled
18. Fibreglass insulation
19. Firelighters
20. Flammable liquids in combustible containers
21. Linoleum
22. Matches
23. Paper tissue rolls horizontally stored
24. Paper (like newspaper), rolls stored vertically
25. Paper, bitumen and wax coated
26. Paper, waste
27. Pharmaceuticals – plastic bottles
28. Photographic paper
29. Plastic furniture
30. Plastic materials other than what is stated in
31. Category-II and expanded-polyurethane and polystyrene
32. Resins excluding flammable liquids
33. Roof felt in rolls vertical storage
34. Rubber goods including tyres and tubes
35. Timber, sawn (in ventilated stacks)
36. Wicker work
37. Wood veneer sheets

d) Category-IV

1. Ammunitions
2. Cardboard, corrugated (in rolls stored vertically)
3. Diapers
4. Expanded polystyrene packagings
5. Foamed rubber
6. Foamed upholstery
7. Liquor bottles other than beer
8. Paints – Oil based and Nail polish
9. Paper tissue rolls vertically stored
10. Tyres, stored horizontally
11. Wax, paraffin
12. Wood veneer sheets
13. Wood wool baled

6 PLANNING STAGE

6.1 Initial Considerations

6.1.1 *Consultation*

Where a sprinkler system or an extension or alteration to a sprinkler system is being considered for new or existing building, the authorities concerned shall be consulted at an early stage:

6.1.2 *Outline Design*

Consideration should be given to any benefits that might be gained by changes in building design, work procedures, etc, when preparing the outline design. In planning site layout and building design, particular consideration should be given to the following:

a) Occupancy hazard class and goods category which determine the water discharge density and water supply pressure and flow;

b) Siting of any main water supply connection(s);

c) Siting of any water supply tank(s) or reservoir;

d) Siting of any pump house;

e) Maximum quantity of water available from the supply source compared with the system requirements;

f) Location of sprinkler installation control valves, together with the access thereto, indication of their position, and the disposal of drainage and water supply test water;

g) Source and means of supply of electric power, etc; and

h) Protection of valve sets, pipework and sprinklers against accidental damage.

6.1.3 It is important to consider building design in the context of fire protection, for example, choice of materials, support of sprinkler pipework having regard to the load imposed on structure by the weight of sprinkler pipework and the contained water, need for inbuilt drainage (which is strongly advised for computer areas) or raising of base of stacked goods above the floor where water damage may be severe, etc, when storage of goods is involved it may be appropriate to consider the height of the building and of material stacks, and the height and type of any storage rack which may have a considerable bearing on fire protection costs. The design of double entry storage racks may be influenced by the need to mount sprinklers therein. Where sprinklers are fitted in racks additional rack structural members may be needed to prevent impact damage to the sprinkler head and pipe work.

6.1.4 *Interaction with Other Fire Protection Measures*

Account shall be taken of possible interaction between sprinkler systems and other fire protection measures. Examples of possible adverse interactions between sprinkler protection and other fire protection measures are:

a) Water damage to an inadequately shielded fire alarm control panel in a sprinkler protected area with consequent possible failure of the fire alarm system.

b) Operation or failure of smoke detectors in zones adjacent to one in which water discharge has taken place because of the water spray mist travelling to adjacent zones.

c) Such possible interactions need careful considerations.

6.2 Extent of Sprinkler Protection

6.2.1 *Building to be Sprinkler Protected*

The sprinkler system shall provide protection to all parts not specified as exceptions (*see* **6.2.2**) in one of the following:

a) Building under consideration;

b) Any building communicating directly or indirectly with the building under consideration;

c) Where there are unprotected buildings within 9 m of protected building the exposure hazard can be reduced by using cut-off sprinklers over unsealed openings and drenchers over exposed walls (such as glass walls which are combustible) in the protected building; and

d) Consideration should be given to the protection of load bearing steel structure.

6.2.2 *Exceptions (Buildings and Parts of Buildings not Sprinkler-Protected)*

Obligations sprinkler protection shall not be provided in the following parts of a building or plant:

a) Grain silos or grain bins inside buildings forming part of corn mill, distillery, maltings or oil mills;

b) Ovens, hovels and kilns in pottery, earthenware, brick, tile and glass works;

c) Areas, rooms or places where the water discharged from a sprinkler may pose a fire or explosion or toxic hazard; and

d) Sprinklers should not be fitted over salt baths, metal melt pans or frying ranges, or in positions where water may discharge into them or indirectly drain into them nor should water pipes be fitted in these positions.

6.2.3 *Optional Exceptions*

Generally sprinkler protection shall be considered for, but need not be provided in, the following parts of a building or plant:

a) Stairs, spaces below stair headings (but not rooms above a stair) and lift wells. Any part not provided with sprinkler protection shall be fire separated by walls. Fire doors not less than 120 min in fire resistance, shall be provided in the openings of such walls;

b) Washrooms, toilets and WCs (but not cloak rooms) of area less than 5 m^2;

c) In paper making machines, the undersides of screens or of shields erected over the wet and (where there is no other fire hazard); and

d) Server rooms and the like, where alternate protection by other automatic extinguishing systems, (for example, gas, powder, water spray, water mist).

6.2.4 Sprinklers shall not be required in electrical equipment rooms where all of the following conditions are met:

a) Room is dedicated to electrical equipment only;
b) Only dry-type electrical equipment is used;
c) Equipment is installed in a 120 min fire-rated enclosure including protection for penetration in walls;
d) Cable coating is done in trays or trenches to prevent flame spread; and
e) Storage is not permitted in the room.

6.2.5 *Communicating Buildings*

Sprinkler protection shall be considered for, but need not be provided in the following communicating buildings or structures:

a) A building or storey segregated from the sprinklered building by walls of not less than 240 min fire resistance in which each opening is protected by two (arranged in series) fire doors or fire shutters each of not less than 120 min fire resistance;
b) Canopies of non-combustible construction, not extending beyond 2.3 m from the building wall. Any such canopy not provided with sprinkler protection shall be fitted with cut-off sprinklers under the canopy over each opening between it and the spinklered building. Any opening 2.5 m or less in width shall be provided with a cut-off sprinkler, positioned centrally over the opening. Openings exceeding 2.5 m in width shall be provided with cut-off sprinklers over the opening, not more than 2.5 m apart and with a sprinkler not more than 1.25 m, from each side;
c) Exterior loading docks and platforms either of the non-combustible construction or with the space beneath closed off against accumulation of debris;
d) Stairs, washrooms and WCs external to the sprinkler-protected building, in which all openings to the sprinkler-protected building are protected by doors of not less than 60 min fire resistance or cut-off sprinklers; and
e) Staircases, washrooms, toilets and WCs external or internal to the sprinkler-protected building which form a means of communication between the sprinklered building and non-sprinklered building. In any such part not provided with sprinkler protection all openings into the communicating area from the sprinklered and from the non-sprinklered building shall be protected by fire doors of not less than 120 min fire resistance rating.

6.3 Storage in Open or Open Sided Shed

The distance between combustible materials stored in the open or in an open-sided shed and the sprinklered building shall be no less than 10 m or 1.5 times the height of the stored material whichever is greater unless there is a 120 min rated fire wall in between or a suitable drencher system to protect the openings of the protected building facing the open storage.

6.4 Protection of Concealed Spaces

a) If the height of the concealed space between main roof and suspended ceiling exceeds 800 mm, measured between the underside of the roof and the top of the suspended ceiling or between the floor and the underside of the raised floor, these spaces shall be sprinkler protected.
b) If the height of the concealed space at roof and suspended ceiling is 800 mm or less but contain combustible materials or are constructed with combustible materials, such spaces shall also be sprinkler protected. Only listed sprinklers for concealed combustible spaces shall be used.

   NOTE — Electrical cables with voltage less than 250 V, single phase, with a maximum of 15 cables, are exempted.

c) The protection in the concealed space shall be designed to light hazard when the main hazard class is pre dominantly light hazard, and ordinary hazard in case of all other occupancies.

6.5 Height Difference Between the Highest and Lowest Sprinklers

a) The height difference between the highest and lowest sprinkler on an installation (that is, connected to a single installation control valve) shall not exceed 45 m.
b) Where the height difference between the highest and lowest sprinkler in a system or building exceeds 45 m, requirements of Annex B shall be applied.

7 SPRINKLERS−GENERAL REQUIREMENTS

7.1 General

Sprinklers shall not be re conditioned or repaired. Sprinklers removed for any reason or used and/or defective sprinklers shall be replaced by new ones. Sprinklers shall not be painted except by the manufacturer for identification purposes. They shall not be altered in any respect nor have any type of ornamentation or coating. Powder and corrosive protection coatings on the frames and deflectors are acceptable only during manufacturing of the sprinkler in line with the approvals and listings for that sprinkler.

7.2 Types of Sprinklers and their Application

Sprinklers shall be selected for use according to the occupancy and its configuration. All types of sprinklers shall be positioned and installed as per various provisions in this standard. Following are the various types of sprinklers that are covered as per this standard:

a) Standard pendent and upright sprinklers;
b) Sidewall spray sprinklers;
c) Extended coverage (EC) sprinklers;
d) Open sprinklers;
e) Intermediate or rack sprinklers;
f) Early suppression fast response (ESFR) sprinklers; and
g) Large drop (LD) sprinklers.

7.2.1 *Standard Pendent and Upright Sprinklers (Conventional, Non-storage Type)*

These are designed to produce a spherical type of discharge with a proportion of water being thrown upwards the ceiling. These are usually built with a universal type deflector enabling the sprinklers to be installed either upright or pendent. It is also possible to designate them for upright or pendent for certain applications.

7.2.2 *Standard Pendent and Upright Sprinklers (Spray Type, Non-storage Type)*

These are designed to produce a hemispherical discharge and nearly no water is directed towards the ceiling. These are built both ways that is upright or pendent. These shall not be used in high hazard, high piled storage risks and also in case of ordinary/high hazard class risks where there is exposed structural steel work or where the roof or ceiling or its supporting structure is of combustible material.

7.2.3 *Ceiling or Flush and Concealed Type of Sprinklers (Non-storage Type)*

These are designed for use with the concealed pipework and are installed pendent with plate or base flush to the ceiling with the heat sensitive element below the ceiling line. These shall be installed only in light or ordinary hazard risks and not for the high hazard class.

Common applications are hotels, boardrooms, offices, retail stores, etc, where the aesthetic appearance is of value. The deflectors are normally integral with the assembly and retracted types of deflectors are also acceptable if approved for the purpose while listing.

7.2.4 *Sidewall Spray Sprinklers (Non-storage Type)*

These are designed to produce a downward paraboloid discharge and the special deflector fitted to the sprinkler causes most of the water to be discharged on the opposing wall and floor with a little of water discharging on the wall behind the sprinkler. These shall not be installed in high hazard applications or above suspended ceilings. These are not substitutes for standard sprinklers but may be used in areas as indicated below; and in offices, hotels, halls, lobbies, corridors, conveyor housings, etc. Sidewall sprinklers are also available with extended discharge types:

a) Corridors/passages/ramp entry and exits.
b) Cable ducts.
c) Columns and structural members in ordinary hazard (OH) and high hazard (HH) storage facilities.
d) Light hazard (LH) and ordinary hazard (OH) without storage.

Where sidewall sprinklers are used for general protection purposes they may only be installed under flat ceilings, unless approved for protection otherwise. Sidewall sprinklers shall not be installed in HH installations or OH storage areas or above suspended ceilings for general protection purposes.

7.2.5 *Extended Coverage Sprinklers (Special, Non-storage Type)*

These types of sprinklers shall be used as follows:

a) Unobstructed construction consisting of flat or smooth ceiling with slope not exceeding 1 in 6 (9°).
b) Unobstructed or non-combustible obstructed construction if specifically approved for such use.
c) Under smooth or flat ceilings with slope not exceeding 1 in 6 (9°) if specifically approved for such use.

The usage of extended coverage sidewall sprinklers (non-storage type) should be restricted to rooms with low fire loadings, such as hotel bedrooms, dwelling units and individual office; unless specifically listed for higher hazards.

7.2.6 *Open or Cut-off Sprinklers (Non-storage Type)*

Sprinklers where the thermal sensing element and the orifice cap have been removed. Normally used in deluge systems where all the sprinklers work in tandem to protect specific hazards or locations.

7.2.7 *Early Suppression Fast Response (ESFR) Sprinklers (Storage)*

These types of sprinklers work on *suppression* mode and shall be used as follows:

a) High challenge storage hazards where storage and ceiling heights are high like 12 m and 14 m, respectively unless listed specifically otherwise. Normally, provision of ESFR sprinklers are not backed up by the intermediate or rack sprinklers unless listed otherwise; and

b) They are used only in wet systems unless specifically approved for use in other types of systems.

7.2.8 *Large Drop Sprinklers (Storage)*

These types of sprinklers work on control mode and shall be used as follows:

a) These sprinklers are used for high challenge fires like storage similar to ESFR sprinklers at heights 10.5 m and 12 m, respectively for storage and ceiling heights. These sprinklers shall need the backup intermediate or rack sprinklers unless listed otherwise.
b) Permissible for installation in wet, dry or pre-action systems.

7.2.9 *Intermediate or Rack Sprinklers (Storage Type)*

These are standard sprinklers only and used in conjunction with ceiling sprinklers for storage application in racks when height of storage exceeds 4 m.

7.3 Sprinklers and Hazard Classes

Sprinkler types, pattern, hazard class, height and K-factor, etc shall be as per Table 1.

7.4 Sprinkler Size and K-Factor

Sprinklers shall have a nominal orifice sizes of 10 mm, 15 mm, 20 mm or 25 mm as shown in Table 1. The K-factor of the sprinkler shall be as per the following equation:

$$K = Q/(P)^{0.5}$$

where

K = K-factor,
Q = Flow through the sprinkler orifice, in lpm, and
P = Pressure at the entry point of the sprinkler, in bar.

The desired 'K' factors for the sprinklers are shown in Table 2.

Table 1 Types of Sprinkler

(*Clauses* 7.3 *and* 7.4)

Sl No.	Hazard Class	Height of Building m	K-Factor	Sprinkler	
				Pattern	Response
(1)	(2)	(3)	(4)	(5)	(6)
i)	Light	Up to 9	57 or 80	Pendent or upright, sidewall type	Quick or standard
		More than 9 but within 15	115	Pendent or upright, sidewall type	Quick or standard
ii)	Moderate	Up to 9	80 or 115	Pendent or upright	Quick or standard
		More than 9 but within 15	115	Pendent or upright	Quick or standard
iii)	High	Up to 9	115 or 160	Pendent or upright	Quick or standard
		More than 9 but within 15	160 and above	Pendent or upright	Quick or standard
iv)	High storage (*see* Note)	Up to 13.7	200 to 400	Pendent or upright	ESFR types
v)	In-rack sprinklers	Not applicable	80 or higher	Pendent or upright	Quick or standard

NOTE – *See also* Annex C.

Table 2 Tolerance, Nominal Size and Discharge of Sprinklers

(*Clause* 7.4)

Sl No.	Nominal K-Factor	Tolerance Range	Nominal Orifice Size mm
(1)	(2)	(3)	(4)
i)	57	56 – 64	10
ii)	80	76 – 84	15
iii)	115	107 – 118	20
iv)	160	159 – 166	20
v)	200	195 – 209	20
vi)	240	231 – 254	20
vii)	280	272 – 301	25
viii)	320	311 – 343	25
ix)	360	349 – 387	25
x)	400	390 – 430	25

7.5 Temperature Rating and Colour Coding

Sprinklers shall have one of the temperature ratings given in Table 3 and shall be correspondingly colour coded.

7.6 Sprinkler Sensitivity Rating

Sensitivity rating of sprinklers shall be according to the type of their pattern as per Table 4.

7.7 Selection of Temperature Rating for Sprinkler

7.7.1 The temperature rating of a sprinkler shall not be less than 30 °C greater than the highest anticipated ceiling temperature of the location (site) of the installation.

NOTE — If the local conditions in occupancies calls for continuous air conditioning round the clock throughout the year, relaxation may be considered.

7.7.2 In high hazard installations protecting high piled storage with or without intermediate sprinklers, the roof or ceiling sprinklers (except ESFR sprinklers) shall have a temperature rating of 141 °C unless specifically listed otherwise. Under glazed roof or where there are roofing sheets of PVC or similar plastic material, the sprinkler rating shall be either 79 °C to 100 °C, or 141 °C for high piled storage. The temperature rating of the roof or ceiling sprinklers within 3 m of the plan area of the boundary of either an oven or a hot process ventilating hood, fitted with sprinklers shall be the same as the oven or hood sprinklers, or 141 °C, whichever is lower. Considering the temperature sensitivity of sprinklers, they shall be located at least 750 mm to 2 000 mm (depending upon the ambient temperature inside) away from hot sources in the blocks concerned.

7.8 Mixing of Different Types of Sprinklers

Different types of sprinklers shall not be used for protecting the same hazard area unless otherwise deemed necessary. Also, the following shall be avoided:

a) Different types of sprinklers normal pendent/upright, extended discharge type, side wall, large drop, ESFR, etc (like storage, non-storage, and special protection sprinklers).
b) Sprinklers having different K-factors.
c) Sprinklers having different orientation.
d) Sprinklers having different nominal temperature ratings.
e) Sprinklers having different nominal RTI values.
f) Sprinklers having different linear and/or area spacing requirements (for example, extended coverage and non-extended coverage sprinklers).

Table 3 Temperature Ratings of Sprinklers

(*Clause* 7.5)

Sl No.	Fusible Link Type		Glass Bulb Type	
	Temperature Rating °C	Colour of Yoke Arm or Operating Element	Temperature Rating °C	Colour of Bulb
(1)	(2)	(3)	(4)	(5)
i)	68/74	Natural	57	Orange
ii)	93/100	White	68	Red
iii)	141	Blue	79	Yellow
iv)	182	Yellow	93	Green
v)	227	Red	121/141	Blue
vi)	–	–	182	Mauve
vii)	–	–	204/260	Black

Table 4 Sensitivity Rating of Sprinklers

(*Clause* 7.6)

Sl No.	Sprinkler Pattern	Sensitivity rating
(1)	(2)	(3)
i)	Conventional, spray and those for K-Factor ≤ 160	Standard or Fast response
ii)	Ceiling or flush, sidewall (upright or pendent)	Fast
iii)	ESFR, LD or EC	Fast
iv)	Recessed, concealed types (including sidewall types)	Unrated

7.9 Protection to the Sprinklers

a) Any sprinkler, other than ceiling or flush sprinkler, installed in a position at risk of accidental damage shall be fitted with a metal guard certified and approved for use with the sprinkler installed. It is particularly important for intermediate sprinklers in storage racks.

b) Sprinklers installed in a rack or under a perforated shelf, platform and the like, where water from higher sprinklers including roof/ceiling sprinklers may cause wetting in close proximity to the bulb or fusible element shall be fitted with metal water shields listed and approved for use with the sprinkler installed. The shield shall not be directly attached to an upright sprinkler deflector or yoke assembly at site, unless it forms an integral part of the sprinkler while manufacturing. Such shield shall form little or no obstructions to the sprinkler spray pattern. Certified/approved water shields (according to the size of various types of sprinklers) can also be used to provide cover for the sprinklers subject to approval of authorities concerned.

c) Sprinkler rosettes shall be provided for the concealed sprinklers, which shall be of metal or thermo-set plastics and shall be suitable for the sprinkler service. No part of the cover plate shall be used to support ceilings or other structures and shall project from the ceiling below the top of the visible portion of the heat sensitive element. It shall be ensured that the cover plates are not painted at site. All coloured or coated cover plates need to be painted or coated by the original manufacture. Cover plates, coated or painted at site shall need to be replaced.

d) Sprinklers installed in areas where corrosive vapours are prevalent shall have corrosion resistant coatings suitable to sprinkler service. Frequent coating with good quality petroleum jelly is recommended. The coating shall however not be applied on the fusible links or the body of the glass bulb.

e) Sprinkler shall be installed only with spanners or wrenches recommended by the manufacturer.

7.10 Spare Sprinklers to be Kept in Stock

A stock of spare sprinklers shall be maintained in the premises so that prompt replacement is possible after the operation/damage of sprinkler heads. The spares shall be kept in an easily accessible location under conditions where the temperature does not exceed 38 °C.

The guidelines as in Table 5 shall be followed in respect of stocking spare sprinkler heads in protected buildings.

Spanners or wrenches for the sprinklers shall also be kept along with the spare sprinklers in readiness.

Table 5 Guidelines for Stocking Spare Sprinklers

(*Clause* 7.10)

Sl No. (1)	Hazard Class (2)	All State Capitals and Within 200 km thereof (3)	Other Locations (4)
i)	Light	5 sprinklers of each type	15
ii)	Ordinary	15 sprinklers of each type	25
iii)	High and Storage	30 sprinklers of each type	50

NOTE — When there is more than one installation within a complex, the above quantity shall also be increased in proportion. Each type of sprinkler used in the installation, such as conventional or spray or ceiling/flush or sidewall sprinklers and appropriate temperatures shall be stocked as per the above requirements.

8 DESIGN AREA AND DENSITY OF APPLICATION

8.1 The design density and the assumed maximum area of operation for various types of hazards are as specified below:

8.1.1 *Light Hazard*

The density of water discharge and design area of operation shall be a minimum of 2.25 lpm/m^2 over a maximum area of 84 m^2. Even if the area concerned is less than 84 m^2, then density applicable shall not be reduced.

8.1.2 *Ordinary Hazard*

The density of water discharge and design area of operation shall be minimum of 5 lpm/m^2 at over a maximum area of 360 m^2. Even if the area concerned is less than 360 m^2, then density applicable shall not be reduced.

Materials can be stored in ordinary hazard occupancies and protected at the same density of water and area of operation when the following conditions are complied with:

a) Maximum storage heights shown in Table 6 shall not be exceeded.

b) Maximum storage areas shall be 50 m^2 for any single block, with no less than 2.4 m clearance around the block.

NOTE — If the conditions are not met, entire occupancy shall be treated as high hazard.

Table 6 Maximum Storage Heights Permissible in Ordinary Hazard Occupancies

[*Clause* 8.1.2 (a)]

Sl No. (1)	Storage Category (2)	Maximum Storage Height m (3)
i)	Category I	4.00
ii)	Category II	3.00
iii)	Category III	2.10
iv)	Category IV	1.25

8.1.3 *High Hazard*

The density of water discharge and design area of operation shall be minimum of 12.2 lpm/m^2 over a maximum area of 260 m^2. If area concerned is less than 260 m^2, then density applicable shall not be reduced.

8.1.4 *Storage Hazard*

Density of water application for storage areas is determined by the flow and pressure requirements based on the type of sprinkler selected (*see* Annex C). Density of application is normally high, in the range of 25-50 lpm/m^2.

8.1.5 *Buildings Like Residential, Hotels and the Like*

For buildings where the occupancy is divided into several rooms it is difficult to locate most demanding design area as per **8.1**. Hence, room area plus communicating space like corridor/passage which constitutes hydraulically most demanding shall be deemed as design area (*see* **8.8**).

8.2 Special Sprinklers

For extended coverage (EC) sprinklers, the minimum design area shall be that corresponding to the hazard classification, or the area protected by five sprinklers whichever is greater. Extended coverage sprinklers shall be designed according to their listing.

For large drop sprinklers, design area shall be a rectangular area having a dimension parallel to the branch lines at least 1.2 times the square root of the area of sprinkler operation used, which shall permit the inclusion of sprinklers on both sides of the cross main.

For *ESFR sprinklers*, the design area shall be a rectangular area that consists of the most hydraulically demanding area of 12 sprinklers, and consisting of 4 sprinklers on each of adjoining branch lines.

For intermediate sprinklers, it shall be assumed that 3 sprinklers are operating simultaneously at the most hydraulically remote position on each level of in-rack sprinklers, up to a maximum of three levels:

a) Where rack aisles are 2.4 m or more in width only one rack needs to be assumed as involved. Where rack aisles are less than 2.4 m but greater than or equal to 1.2 m in width, two racks shall be assumed to be involved.
b) Where rack aisles are less than 1.2 m in width, three racks shall be assumed to be involved.
c) It is not necessary to assume simultaneous operation of neither more than three rows of sprinklers in the vertical plane nor more than three rows of sprinklers in the horizontal plane.

8.3 Adjustment in Area of Operation (Design Area)

a) In case of sloping roofs, area of operation (design area) shall be increased by 30 percent without increasing the density of application when the slope angle exceeds 1 in 6 (9°) for all non-storage applications in case of all types of sprinklers except sidewall and ESFR sprinklers.
b) In case of dry pipe systems and double lock pre-action systems, area of sprinkler operation (design area) shall be increased by 30 percent without increasing the density of application.
c) Where high temperature sprinklers are used for high hazard occupancies, area of operation (design area) shall be reduced by 25 percent without revising the density of application subject to minimum area of 185 m^2.
d) Where area of operation (design area) are required to be adjusted for more than one of conditions stated in (a), (b) and (c) above, adjustments shall be compounded based on area of operation (design area) as per **8.1**.
e) Concealed spaces whether combustible or non-combustible shall be considered on the same basis as above with regard to design area and design density unless such spaces are less than 5 m^2 in area.

8.4 Communicating Hazards

Where two differential hazards are not separated by fire walls, required sprinkler protection for the more demanding design basis shall extend 6 m beyond its perimeter.

8.5 Water Curtain Sprinklers

Sprinklers in a water curtain shall be suitably designed to provide a discharge of at least 35 lpm for every linear metre of openings (intended to be protected) and it shall be ensured that each sprinkler discharges at least 55-80 lpm at 1.4 bar pressure depending upon spacing between nozzles which shall not exceed 2.5 m.

Water supply required for curtain sprinklers shall be added to the main installation requirements as stated in **13**.

NOTES

1 Water curtain sprinklers are with open type nozzles; and generally there is no restriction of usage (location) as they only provide a blanket effect and protect particular areas where separation is required.

2 The number of sprinklers required to operate can be obtained from the length of wall also. Say, for a 20 m long wall, total flow required can be 700 lpm (20 * 35 lpm). Assuming each sprinkler discharges 60/80 lpm, 12 number of sprinklers may be required; each spaced at say 1.7 m (20 m/12).

8.6 Exposure Protection

a) Piping shall be suitably designed to provide a minimum of 0.5 bar pressure at any sprinkler when all the sprinklers facing the exposure operating together.

b) It is also advisable to provide sprinklers at a minimum of 0.5 bar pressure for the entire exposed load bearing columns from diagonally opposite sides of the columns.

c) Water supply required for exposure protection sprinklers shall be added to the main installation requirements as stated in **13**.

d) A single line of sprinklers is permitted to protect a maximum of two stories of wall area or two levels of vertically aligned windows where architectural features are sufficiently flush to allow rundown.

e) Where window sills or similar features result in recesses or projections exceeding 25 mm in depth, separate sprinklers shall be provided for each window on each level, regardless of whether protection is being provided for windows or complete walls.

f) For protection systems of glass walls, sprinklers shall be located (150 mm to 300 mm) from the wall surface and within 150 mm of the top of the wall, with maximum spacing of 2.4 m or as indicated in the sprinkler listing for exposure protection use.

g) For protection of window and similar openings, listed window sprinklers shall be positioned within 50 mm of the top of the window sash.

8.7 Sprinklers Provided in Ducts

Such sprinklers shall be so designed to provide a discharge pressure of at least 0.5 bar at each sprinkler when all operate together.

NOTE — Return air ducts and plenums shall be provided with sprinklers. Supply air ducts need not be provided with sprinklers.

8.8 Buildings like Residential, Hotels

Sprinkler installation for the above type of buildings where the occupancy is divided into several room (*see* **8.1.5**) shall be as per the following:

a) All the rooms shall be enclosed with walls having a fire resistance of 30 min except the external wall leading outside which shall have a rating of at least 60 min.

b) If the area of the most demanding largest room is less than what is stated in **8.1**, then minimum area specified therein shall be considered for determining design density.

c) Door openings shall be protected with fire doors of at least 30 min fire rating.

d) Where all the rooms are opening to a corridor, design area for the room with largest demand shall include at least 2 sprinklers from the corridor for light hazard and 5 sprinklers for ordinary hazard occupancies.

e) Where the design area in such buildings involves service chutes, at least 3 sprinklers in chutes shall be included in the design area, considering a discharge of at least 55 – 80 lpm per sprinkler.

f) Sprinklers used in hotel guest rooms and adjoining corridors as well as all dwelling units in apartment buildings shall be listed quick response or listed residential sprinklers.

8.9 Window Sprinklers

a) These sprinklers can be used as interior protection of windows or glazing in a sprinklered or non-sprinklered building for providing exposure protection. These shall be installed as per the manufacturer’s installation manual subject to listing conditions.

b) Window sprinklers shall be permitted to cover more than 20 m^2 of window area per level.

c) The starting pressure shall be calculated based on the application rate over 2 m^2 of window area.

d) The maximum spacing between window sprinklers shall not exceed 2.4 m unless listed for a greater distance.

e) Up to 1.5 m width of windows, sprinklers with K-factors of 40 shall be used for each window and installed at a distance of 200 mm from the windows. For more than 1.5 m and up to 3 m width, 2 sprinklers with K-factors of 40 shall be used for each window and installed at a distance of 250 mm from the windows.

8.10 Reference shall be made to Annex G of SP 7 (Part 4) for exhaustive requirements to protect commercial cooking equipment by automatic sprinkler installation.

9 DESIGN APPROACH – SPACING, LOCATION AND INSTALLATION

9.1 General Requirements

a) Entire block or building concerned shall be sprinklered as per the provisions given here under. No occupancy shall be allowed partial protection with sprinklers unless such portions of the building are exempted under the clause ‘allowed exceptions’ or segregated from non-sprinklered portions by fire walls and fire doors with at least 120 min rating.

b) Sprinklers shall be so located that protection area for each sprinkler as specified below is not breached. In no case, protection area shall not exceed the requirement indicated.

c) Sprinklers can be omitted from areas within the protected building as specified under ‘allowed exceptions’.

d) All the measurements between sprinklers or of areas covered by groups of individual sprinklers shall be taken in the horizontal plane. Not with standing the above provisions, the hydraulic calculations shall show the dimensions of true lengths measured along the slope of the pipe.

e) Sprinklers shall be installed upright or pendent as required under the circumstances, with the deflector parallel to the slope of the roof, ceiling or pitch line of stairs. Where the slope of the roof is greater than 1 in 3, a line of sprinklers shall be fitted at the apex unless there is a row of sprinklers at not more than 750 mm distant radially therefrom.

f) Components of the system like valves, gauges, etc, shall be accessible round the clock for inspection, test and maintenance.

9.2 Other Limitations (Size of the Installation)

a) For sprinkler systems based on area protection limitation, detailed design shall be carried out based on maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser with limitations in as shown in Table 7 under one installation control valve [*see* **B-2.6**(c)].

b) In case of multiple hazard or mixed occupancy like high hazard with ordinary hazard, respective limits shall prevail that is, area occupied for high hazard occupancy shall not exceed 3 720 m^2 and total area shall not exceed 4 830 m^2 on one or more floors for a single system and so on.

c) Detached occupancies (falling under differential hazards) communicating with each other shall also fall to be treated under area limitations as stated above.

d) Detached occupancies shall always be provided with separate systems subject to area limitations as above. In case, where the number of sprinklers is less than 50, such occupancies may be allowed to be supplied by system from the adjoining building. However, one system shall not feed more than two buildings.

Table 7 Maximum Area to be Covered by Sprinklers

[*Clause* 9.2(a)]

Sl No. (1)	Hazard Type (2)	Floor Area m^2 (4)
i)	Light	4 830
ii)	Ordinary	4 830
iii)	High	3 720
iv)	Storage	3 720

NOTES

1 Floor area of a mezzanine floor shall not be included in the above area restriction if situated within the boundary of the building.

2 Attention is drawn to **4** of SP 7 (Part 4) regarding requirements for floor and basement compartmentations respectively.

9.3 Installation Philosophy

Following are the parameters that define the sprinkler spacing, location and distribution and these changes according to the type of application and sprinklers used in protection:

a) Minimum and maximum area of coverage for each sprinkler;

b) Maximum linear distance between sprinkler;

c) Minimum linear distance between sprinklers;

d) Maximum linear distance from sprinkler to walls;

e) Minimum linear distance from sprinkler to walls;

f) Deflector position and orientation with regard to roof;

g) Obstruction to sprinkler discharge or affecting their pattern (umbrella or inner core);

h) Clearance to storage below in case of storage hazards;

j) Location near skylight and special structure; and

k) Network layout standard, staggered, gridded, looped, etc.

9.4 Determination of Area of Coverage for Each Sprinkler

9.4.1 *Sprinklers Other than Sidewall Type*

The area shall be the product of,

a) largest spacing between sprinklers along branch lines OR twice the largest distance between the extreme sprinklers in branch lines and the walls whichever is higher; and

b) largest distance between sprinklers in two adjoining branch lines OR twice the largest distance between sprinklers in the branch lines and the wall.

NOTE — For small rooms or enclosures, protection area shall be calculated by the total area of the room divided by number of sprinklers provided within.

9.4.2 *Sidewall Sprinklers*

The area shall be the product of,

a) largest spacing between sprinklers along the wall OR twice the largest distance between the extreme sprinklers to the end of wall whichever is higher; and

b) distance between two opposite walls if sprinklers are installed only on one wall OR distance between sprinkler and middle of the room if sprinklers are installed on both walls.

9.5 Maximum Distance Between Sprinklers

Maximum distance between sprinklers shall be based on centre to centre distance between sprinklers in a range pipe or those in adjoining range pipe. Maximum distance shall be measured along the slope of the ceiling.

9.6 Minimum Distance Between Sprinklers

A minimum distance between sprinklers in compulsory, to prevent an operating sprinkler from wetting the adjoining sprinkler and thus prevent skipping of sprinklers.

9.7 Maximum Distance from Sprinkler to the Walls

The distance between the boundary (walls) and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing between the sprinklers and when measured perpendicular to the range pipe shall not be more than 0.5 times the spacing between the range pipes.

However, where the external walls are combustible or built with metallic or otherwise; or open sided and also in case of open joisted ceilings or where the roof has the rafters exposed, the distance between the boundary and the sprinklers shall not exceed 1.5 m.

Distance shall be measured perpendicular to the wall.

9.8 Minimum Distance from Sprinkler to the Walls

Minimum distance shall be maintained as mentioned under the respective clauses for each type of sprinkler.

9.9 Deflector Location and Orientation

Obstructions to sprinkler installation can arise due to,

a) presence of structural members like columns, beams, girders, joists, etc and
b) due to other constructions like dwarf walls, machinery parts, etc.

Obstructions may prevent sufficient coverage or may interfere with discharge pattern of the sprinklers. There could be continuous obstruction below the sprinklers also. Hence, location and orientation of the sprinkler deflectors assumes significance towards ensuring optimum protection.

9.10 Installation Due to Peculiar Constructional Features

9.10.1 *Columns*

As far as possible, the sprinklers shall be located away from the columns. Where a roof or ceiling sprinkler is less than 0.6 m from the face of a column, another sprinkler shall be located not more than 2 m from the opposite side of the column.

9.10.2 *Girders*

Where the top flange of a girder is not more than 200 mm in width, sprinklers shall be either positioned either not less than 1.2 m from the side of the girder or directly above the girder with the deflector not less than 150 mm from the top face of the girder. Where the top flange of the girder is more than 200 mm in width, sprinklers shall be positioned not less than 1.2 m from the side of the girder.

9.10.3 *Roof Trusses*

Where the roof truss members are not more than 100 mm wide, sprinklers shall be positioned either not less than 0.3 m from the side of the truss or equidistant from each side of the truss with the deflector not less than 150 mm above any truss member. Where the truss members more than 100 mm but less than 200 mm wide, sprinklers shall be positioned either not less than 0.6 m from the side of the truss or equidistant from each side of the truss with the deflector not less than 150 mm above any truss member. Where the truss members are more than 200 mm wide, sprinklers shall be positioned not less than 0.6 m from the sides of the truss.

9.10.4 *Beams and Bays*

Where narrow bays are formed between beams spaced at not more than 1.5 m between centres, the following spacing shall be used:

a) One row of sprinklers shall be installed in the centre of each 3rd bay, with another row underneath the centre line of the beam separating the two unprotected bays.
b) Maximum distance between sprinklers in the other direction, that is along the bay shall be in accordance with the rules for the hazard class involved.
c) Sprinklers shall be installed at a distance no greater than 1 m from walls parallel to the beams and no greater than 1.5 m from walls perpendicular to the beams.
d) Sprinklers installed inside bays shall be placed such that the deflectors are between 75 mm and 150 mm below the underside of the ceiling.

9.10.5 *Concealed Space*

Concealed spaces less than 5 m^2 in area shall not require sprinkler protection.

a) *Roof Space* — Spaces between roofs and ceilings (including those at the apexes and sides of buildings) more than 0.8 m deep measured between the highest point under the roof and the top of the ceiling shall be sprinkler protected.
b) *Intermediate Floor Space* — Concealed spaces between floors and ceilings shall be sprinklered where they are:
    1) more than 0.8 m deep;
    2) not wholly of non-combustible construction; or
    3) containing combustible materials.

9.10.6 *Space Under Lowest Floor*

Sprinklers shall be installed in all spaces below the lowest floors in a building where the floor is combustible and:

a) the space is accessible for storage purpose and/or entrance of unauthorized persons and/or accumulation of waste and debris and/or is not sealed against liquid spillage;

b) the space contains utility piping and installation such as air, steam, wiring, shafting, conveyors, etc; and

c) flammable liquids are stored in the floor above.

NOTE — In all cases, sprinklers installed above and below ceilings and also floor voids shall be of same type.

9.10.7 *Vertical Change in Ceiling Elevation (Applicable only to Pendent and Upright Sprinkler for Standard and Extended Coverage)*

Where there is a vertical change in ceiling elevation less than 900 mm, sprinklers shall be spaced as though there were no change in elevation provided the obstruction rules are observed while locating the sprinklers on the upper ceiling (*see* Fig. 5).

Where there is a vertical change in ceiling elevation more than 900 mm, the change in elevation shall be treated as wall and sprinklers spaced accordingly. (*see* Fig. 6).

9.11 Escalators and Staircase Wells

9.11.1 Staircase wells shall be fully sprinklered including beneath the stairways if they are of combustible construction. For non-combustible staircases, sprinklers shall be provided at the landings at the top and bottom of the wells. Sprinklers shall be installed in the following areas for escalators:

a) In the passenger carrying space;

b) Below the ceiling below escalator;

c) Between the ceiling below the escalator and the passenger carrying space;

d) In the escalator boot; and

e) In the motor areas.

9.11.2 The number of sprinklers shall be increased around the ceiling opening formed by escalators, stairs, etc. Sprinklers shall be neither more than 2 m nor less than 1.5 m away from each other and located at 150 mm to 300 mm from such openings. If, owing to the design of the structure, for example, girders, the minimum distance of 1.5 m cannot be maintained, smaller spacing may be used provided adjacent sprinklers do not wet each other.

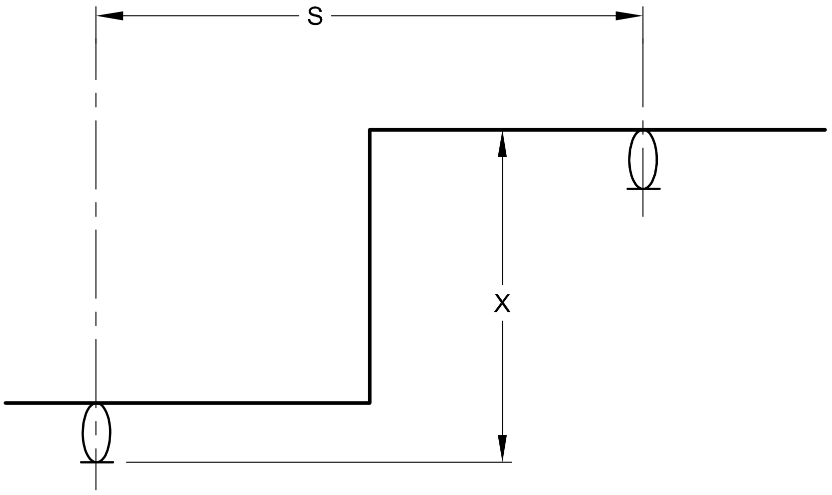
9.11.3 The horizontal distance between the sprinklers and the opening in the ceiling shall not exceed 0.5 m. These sprinklers shall be capable of providing the minimum flow rate per sprinkler in the rest of the ceiling protection.

9.11.4 Vertical openings larger than 6 m (horizontal distance) or 100 m^2 area (whichever is greater) as seen at malls, atrium buildings and the like shall need no protection if adjoining levels and spaces are already protected with sprinklers.

9.12 Obstruction Below Sprinklers

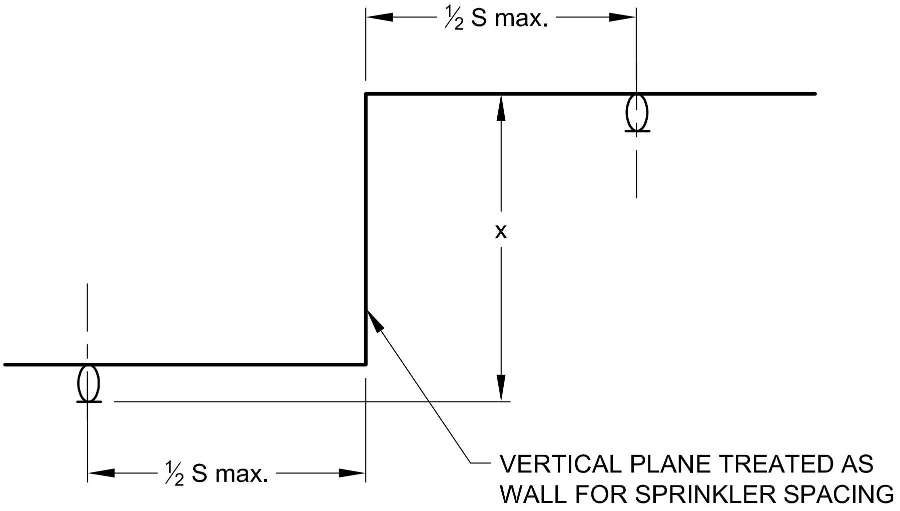
9.12.1 Sprinklers shall be fitted under the following types of obstructions which are; either more than 0.8 m wide and less than 150 mm from the adjacent wall or partitions; or more than 1 m in width.

9.12.2 Internal overhead platforms, heating panels, galleries, walkways, staging other than in film or television studios and stairs and stairways.



X LESS THAN 900mm
S NORMAL SPACING

FIG. 5 VERTICAL CHANGE IN CEILING ELEVATION LESS THAN 900 mm



`X MORE THAN 900mm, S SHALL BE AS SHOWN ABOVE

FIG. 6 VERTICAL CHANGE IN LING ELEVATION MORE THAN 900 mm

9.12.3 Sprinklers shall be fitted below the ducts under the following circumstances:

a) Rectangular and more than 0.8 m wide and less than 150 mm from the adjacent walls or partitions;
b) Circular and more than 1 m in diameter and less than 150 mm from the adjacent walls or partitions;
c) Rectangular and more than 1 m in width; and
d) Circular and more than 1 m in diameter;

9.12.4 Sprinklers are not required under movable obstructions, such as conference tables and the like.

9.12.5 *Hoods Over Paper Making Machines*

Sprinklers shall be fitted under the hoods or shields over the dry ends of above machines, if there is an enclosure.

9.12.6 *Worktables*

Sprinklers shall be fitted under the worktables where there is a power source or where combustible process waste may accumulate (in industrial and storage applications only).

NOTE — Sprinklers installed under obstructions shall be of same type as of ceiling.

9.13 Exterior Docks, Platforms and Canopies

Sprinklers shall be fitted under the exterior docks and platforms of combustible construction unless such spaces are sealed against accumulation of debris and waste.

Canopies that are non-combustible and less than 2 m from the wall of the building need not be protected with sprinklers provided cut-off sprinklers are fitted at the door openings leading to the canopies. However, under other circumstances, the underside of the canopies shall be fitted with sprinklers.

9.14 Unless other specifically provided, a clear space of 0.5 m shall be maintained below the deflector of the sprinkler heads in all cases except high piled combustible storage areas/jute storage and above open suspended ceilings where the clear space required as above shall be 1 m.

9.15 Vertical Shafts and Chutes

In shafts, sprinklers shall be installed at each alternate floor level and at the top of any trapped section. At least one sprinkler shall be installed at the top of all shafts except where the shaft is incombustible and inaccessible.

9.16 Suspended Ceilings

The use of suspended ceiling material below the sprinklers is not allowed unless the material has been shown not to impair sprinkler protection. Where sprinklers are fitted below suspended ceilings, the ceiling material shall be of a type, which has been shown to be stable under fire conditions.

Following clauses are applicable to each type of sprinkler application with regard to design spacing, location and distribution of sprinklers.

9.17 Standard Pendent and Upright Sprinklers

9.17.1 Protection area shall not exceed the following:

a) Light hazard : 21 m^2
b) Ordinary hazard : 12 m^2
c) High hazard : 9 m^2

9.17.2 The maximum distance between the sprinklers shall be as follows:

a) Light hazard	:	4.5 m
b) Ordinary hazard	:	4.5 m
c) High hazard	:	3.75 m

9.17.3 The minimum distance between sprinklers for all hazards shall be 1.8 m without exception. In case of intermediate sprinklers, protecting commodities in racks, distances lower than 1.8 m may be considered, if necessary.

9.17.4 Maximum distance from walls shall be as follows:

a) The distance between the boundary (walls) and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing between the sprinklers and when measured perpendicular to the range pipe shall not be more than 0.5 times the spacing between the range pipes.

b) However, where the external walls are combustible or built with metallic or otherwise or open sided; and in case of open joisted ceilings or where the roof has the rafters exposed, the distance between the boundary and the sprinklers shall not exceed 1.5 m.

c) Distance shall be measured perpendicular to the wall.

9.17.5 *Minimum distance from walls*

The sprinklers shall be located at a minimum distance of 100 mm from the wall.

9.17.6 Sprinkler deflector location and orientation in relation to building structure.

a) *Roofs and Ceilings* (*without Obstructions*) — For conventional and spray type of sprinklers, the sprinklers shall be installed in such a way that the deflectors are at distances as shown in Table 8.

b) *Roofs and Ceilings* (*with Obstructions*):

   1) No specific rules provision is defined to overcome different types of obstructions. However, the guidance in Table 9 shall be adopted to overcome the difficulties faced by obstructions to discharge (*see* Fig. 7).

   2) Sprinklers shall be located so as to minimize obstructions to discharge or away from those directly underneath. Where not possible, additional sprinklers shall be introduced to provide adequate coverage to the hazard.

Table 8 Sprinkler Location Below Ceilings

[*Clause* 9.17.6(a)]

Sl No.	Type of Ceiling	Distance mm		
		Minimum	Maximum	Preferred
(1)	(2)	(3)	(4)	(5)
i)	Combustible, asbestos cement sheets, wired glass and other types of frangible elements	75	300	150
ii)	Combustible with exposed rafters and/or open joists	75	150	–
iii)	Non-combustible, either plane or arched or sloping	75	450	300

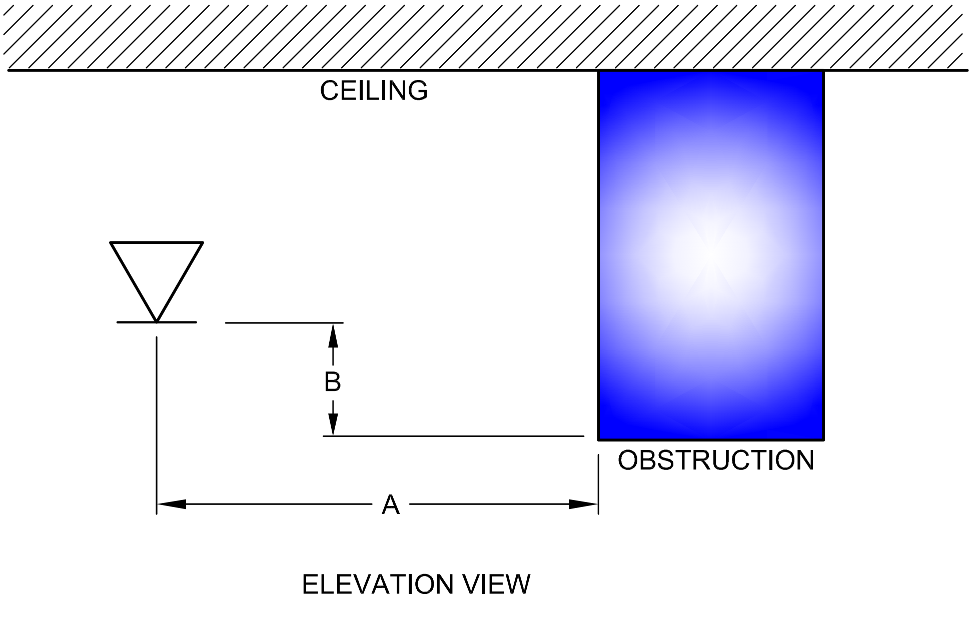


FIG. 7 POSITIONING OF SPRINKLER TO AVOID OBSTRUCTIONS TO DISCHARGE

Table 9 Sprinkler Location in Relation to Obstructions (*see* Fig. 7)

[*Clause* 9.17.6 (b) (1)]

Sl No	Distance (A) Between Sprinklers and the Obstruction on Side mm	Distance (B) Between Deflector Above the Bottom of Obstruction m
(1)	(2)	(3)
i)	Less than 300	0
ii)	More than 300 but less than 450	65
iii)	More than 450 but less than 600	90
iv)	More than 600 but less than 750	140
v)	More than 750 but less than 900	190
vi)	More than 900 but less than 1 150	240
vii)	More than 1 100 but less than 1 200	300
viii)	More than 1 200 but less than 1 400	350
ix)	More than 1 400 but less than 1 500	415
x)	More than1 500 but less than 1 700	450
xi)	More than 1 700 but less than 1 800	500
xii)	More than 1 800 but less than 2 000	600
xiii)	More than 2 000 but less than 2 100	750
xiv)	More than 2 100	875

9.18 Standard Sidewall Sprinkler

9.18.1 *Protection Area*

Protection area shall not exceed the following:

a) Light hazard (combustible ceiling) : 11 m^2

b) Light hazard (non-combustible ceiling) : 18 m^2

c) Ordinary hazard (combustible ceiling) : 7.5 m^2

d) Ordinary hazard (non-combustible ceiling) : 9 m^2

9.18.2 *Maximum Distance Between the Sprinklers*

a) Maximum distance between the sprinklers shall be measured along the slope of the ceiling.

b) Spacing between sprinklers shall not exceed 4.3 m for light hazard occupancies and 3 m in case of ordinary hazard occupancies.

c) Sidewall sprinklers shall not be installed back-to-back without being separated by a continuous lintel or soffit.

d) Sidewall sprinklers shall be permitted to be installed on opposing or adjacent walls, provided no sprinkler is located within the maximum protection area of another sprinkler.

e) When sidewall sprinklers are installed on two opposite walls or sides of bays, maximum width of the room or bay shall be permitted to be up to 7.3 m for light hazard occupancies and 6.1 m for ordinary hazard occupancies.

9.18.3 *Minimum Distance Between Sprinklers*

Sprinklers shall be spaced not less than 1.8 m centre-to-centre. The distance from the wall to the sprinkler shall be measured perpendicular to the wall.

9.18.4 *Maximum Distance from Walls*

The distance from sprinklers to the end walls shall not exceed one half of the allowable distance between sprinklers.

9.18.5 *Minimum Distance from Walls*

Sprinklers shall be located at a minimum of 100 mm from an end wall. The distance from the wall to the sprinkler shall be measured perpendicular to the wall.

9.18.6 *Sprinkler Deflector Location and Orientation*

a) Sprinklers shall be so located to minimize obstructions (to discharge) either on parallel or perpendicular sides thereof. If required, additional sprinklers shall be provided to obviate the obstructions.

b) Sprinklers shall be located at least 1.2 m away from any lighting, fan and similar fixtures either in front of or in the same wall where the sprinklers are mounted. For any obstruction (to discharge) including lighting, fan and the like beyond 1.2 m, location of sprinkler shall be as given in Table 10 and Table 11; *see* Fig. 8 and Fig. 9, respectively.

c) Clearance between the top of storage if any to the deflector shall not be less than 450 mm.

d) Side wall sprinklers in rooms shall neither be installed above the grills of air conditioner nor within 450 mm thereof on the same wall.

e) Distance between sprinklers and the ceiling shall not exceed 150 mm. If specifically approved for use and listed so, the distances between ceilings and the sprinklers can be increased up to 450 mm.

f) Vertical side wall sprinkler deflectors shall be located not more than 150 mm or less than 100 mm from the wall from which they are projecting.

g) Horizontal sidewall sprinkler shall be located not more than 100 mm and are allowed to be located with their deflectors less than 100 mm from the wall on which they are mounted.

h) Deflectors of the sprinklers shall be aligned parallel to the ceilings or roofs.

j) When installed under a sloped ceiling (1 in 6), sidewall sprinklers shall be located at the high point of slope and positioned so as to discharge down the slope.

k) Where soffits used for the installation of sidewall sprinklers exceed 200 mm in width or projection from the wall, additional sprinklers shall be installed below the soffit.

m) When soffits used are within 200 mm in width or projection from the wall, additional sprinklers shall not be required subject to the deflector of the sprinklers falling within prescribed distance as contained in (e) above.

Table 10 Sprinkler Location in Relation to Obstructions (Facing Across the Wall) (*see* Fig. 8)

[*Clause* 9.18.6 (b)]

Sl No. (1)	Distance (A) Between Sprinklers and the Obstruction on Side mm (2)	Distance (B) Between Deflector Above the Bottom of Obstruction mm (3)
i)	Up to 1 200	Not allowed
ii)	More than 1 200 but less than 1 500	25
iii)	More than 1 500 but less than 1 650	50
iv)	More than 1 650 but less than 1 800	80
v)	More than 1 800 but less than 1 950	100
vi)	More than 1 950 but less than 2 100	150
vii)	More than 2 100 but less than 2 250	180
viii)	More than 2 250 but less than 2 400	230
ix)	More than 2 400 but less than 2 550	280
x)	More than 2 550	350

9.19 Extended Sidewall Sprinklers

9.19.1 *Protection Area*

Protection area shall not be less than the value prescribed in the listing and in any case, shall not exceed the values as below:

a) Light hazard (unobstructed smooth and flat ceiling) : 37.2 m^2

b) Ordinary hazard (unobstructed smooth and flat ceiling) : 37.2 m^2

9.19.2 *Maximum Distance Between the Sprinklers*

a) Maximum distance between the sprinklers shall be measured along the slope of the ceiling.

b) Spacing between sprinklers shall not exceed 8.5 m for light hazard occupancies and 7.3 m in case of ordinary hazard occupancies.

c) Sidewall sprinklers shall not be installed back-to-back without being separated by a continuous lintel or soffit.

d) Sidewall sprinklers shall be permitted to be installed on opposing or adjacent walls, provided no sprinkler is located within the maximum protection area of another sprinkler.

Table 11 Sprinkler Location in Relation to Obstructions (Along the Same Wall) (*see* Fig. 9)

[*Clause* 9.18.6 (b)]

Sl No. (1)	Distance (A) Between Sprinklers and the Obstruction on Side mm (2)	Distance (B) Between Deflector Above the Bottom of Obstruction mm (3)
i)	100 to 150	25
ii)	More than 150 but less than 300	50
iii)	More than 300 but less than 450	80
iv)	More than 450 but less than 600	115
v)	More than 600 but less than 750	150
vi)	More than 750 but less than 900	180
vii)	More than 900 but less than 1 050	200
viii)	More than 1 050 but less than 1 200	230
ix)	More than 1 200 but less than 1 350	250
x)	More than 1 350 but less than 1 500	300
xi)	More than 1 500 but less than 1 650	330
xii)	More than 1 650 but less than 1 800	350
xiii)	More than 1 800 but less than 1 950	380
xiv)	More than 1 950 but less than 2 100	430
xv)	More than 2 100 but less than 2 250	450

9.19.3 *Minimum Distance Between Sprinklers*

Sprinklers shall be spaced not less than 1.8 m centre to centre. The distance from the wall to the sprinkler shall be measures perpendicular to the wall.

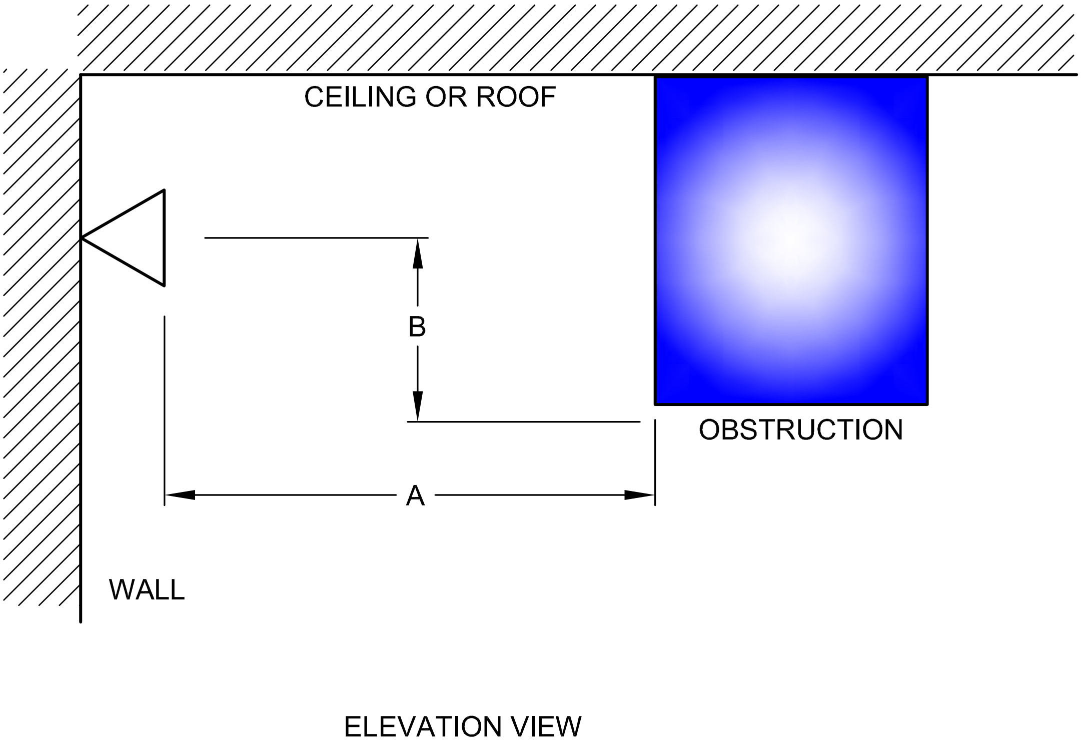


FIG. 8 SPRINKLER FACING OBSTRUCTION ACROSS

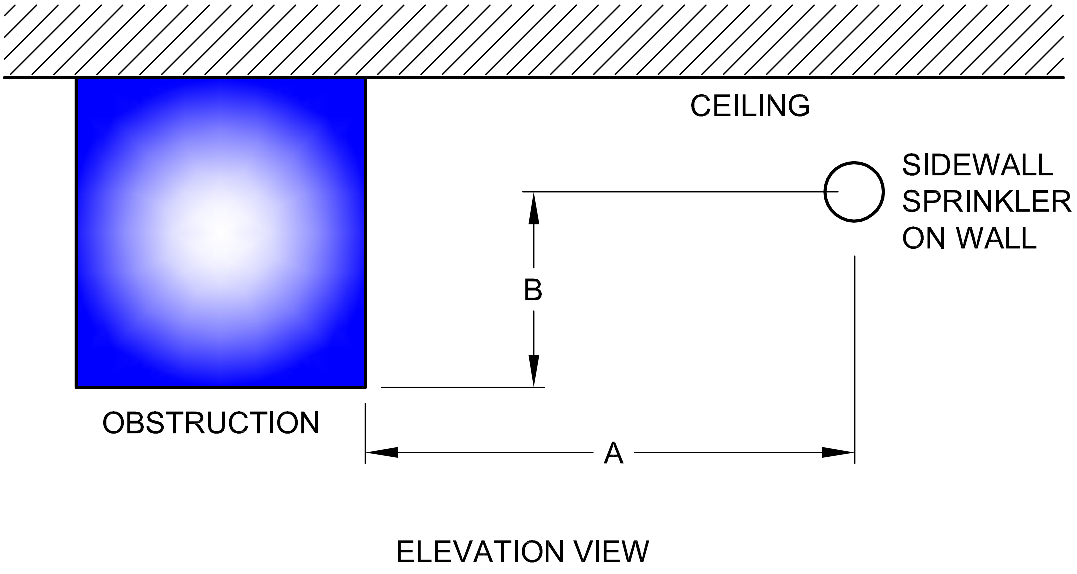


FIG. 9 SPRINKLER FACING OBSTRUCTION ALONG SAME WALL

9.19.4 *Maximum Distance from Walls*

The distance from sprinklers to the end walls shall not exceed one half of the allowable distance between sprinklers.

9.19.5 *Minimum Distance from Walls*

Sprinklers shall be located a minimum of 100 mm from an end wall. The distance from the wall to the sprinkler shall be measured perpendicular to the wall.

9.19.6 *Sprinkler Deflector Location and Orientation*

a) Sprinklers shall be so located to minimize obstructions (to discharge) either on parallel or perpendicular sides thereof. If required additional sprinklers shall be provided to obviate the obstructions.
b) Sprinklers shall be located at least 2.4 m away from any lighting, fan and similar fixtures either in front of or in the same wall where the sprinklers are mounted. For any obstruction (to discharge) including lighting, fan and the like beyond 2.4 m, location of sprinkler shall be as per the Tables 12 and 13 (*see also* Fig. 8 and Fig. 9).
c) Clearance between the top of storage if any to the deflector shall not less than 450 mm.
d) Side wall sprinklers in rooms shall neither be installed above the grills of air conditioner nor within 450 mm thereof on the same wall.
e) Side wall sprinklers shall be located not more than 150 mm or less than 100 mm from the ceilings.
f) If specifically approved for use and listed so, the distances between ceilings and the sprinklers can be increased up to 450 mm.
g) Vertical side wall sprinkler deflectors shall be located not more than 150 mm or less than 100 mm from the wall from which they are projecting.
h) Horizontal sidewall sprinkler shall be located not more than 100 mm and are allowed to be located with their deflectors less than 100 mm from the wall on which they are mounted.
j) Deflectors of the sprinklers shall be aligned parallel to the ceilings or roofs.
k) When installed under a sloped ceiling (1 in 6), sidewall sprinklers shall be located at the high point of slope and positioned so as to discharge down the slope.
m) Where soffits used for the installation of sidewall sprinklers exceed 200 mm in width or projection from the wall, additional sprinklers shall be installed below the soffit.
n) When soffits used are within 200 mm in width or projection from the wall, additional sprinklers shall not be required subject to the deflector of the sprinklers falling within prescribed distance as contained in (e).

Table 12 Deflector Orientation Due to Obstructions Perpendicular to the Sprinkler (*see* Fig. 8)

[*Clause* 9.19.6 (b)]

Sl No. (1)	Distance (A) Between Sprinklers and the Obstruction on Side mm (2)	Distance (B) Between Deflector Above the Bottom of Obstruction mm (3)
i)	< 2 400	Not allowed
ii)	2 400 to less than 3 000	25
iii)	3 000 to less than 3 300	50
iv)	3 300 to less than 3 600	75
v)	3 600 to less than 3 900	100
vi)	3 900 to less than 4 200	150
vii)	4 200 to less than 4 500	175
viii)	4 500 to less than 4 800	225
ix)	4 800 to less than 5 100	275
x)	> 5 100	350

Table 13 Deflector Orientation Due to Obstructions Parallel to the Sprinkler (*see* Fig. 9)

[*Clause* 9.19.6 (b)]

Sl No. (1)	Distance (A) Between Sprinklers and the Obstruction on Side mm (2)	Distance (B) Between Deflector Above the Bottom of Obstruction mm (3)
i)	< 450	Not allowed
ii)	450 to less than 900	25
iii)	900 to less than 1 200	75
iv)	1 200 to less than 1 350	125
v)	1 350 to less than 1 800	175
vi)	1 800 to less than 1 950	225
vii)	1 950 to less than 2 100	275
viii)	2 100 to less than 2 250	350

9.20 Extended Coverage (EC) Sprinklers (Upright and Pendent)

9.20.1 These sprinklers shall not be used for the protection of buildings with combustible construction.

9.20.2 *Protection Area and Maximum Spacing for EC Sprinklers*

Protection area shall not be less than the value prescribed in the listing and in any case, shall not exceed the values shown in the Table 14. Also, maximum spacing between sprinklers for various areas are shown in the Table 14.

9.20.3 *Minimum Distance Between Sprinklers*

Sprinklers shall not be located less than 2.4 m centre-to-centre.

Table 14 Protection Area and Maximum Spacing (EC Sprinklers)

[*Clauses* 9.20.2, 9.20.4 *and* 10.1 (e)]

Sl No.	Hazard Classification	Protection Area m^2	Maximum Spacing m
(1)	(2)	(3)	(4)
i)	Light	37.20	6.00
		30.00	5.50
		24.00	5.00
ii)	Ordinary	37.20	6.00
		30.00	5.50
		24.00	5.00
		18.20	4.30
		13.40	3.70
iii)	High	18.20	4.25
		13.40	4.60
iv)	High-piled storage	18.20	4.25
		13.40	4.60

9.20.4 *Maximum Distance from Walls*

a) The distance from sprinkler to walls shall not exceed one half of the allowable distance as per values shown in Table 14:

b) The distance from wall to sprinkler shall be measured perpendicular to the wall.

9.20.5 *Minimum Distance from Walls*

Sprinklers shall be located a minimum of 100 mm from a wall.

9.20.6 *Sprinkler Deflector Location and Orientation*

a) Distance between the sprinkler deflector and ceiling shall be minimum of 25 mm and maximum of 300 mm throughout the area of coverage of sprinkler protection for buildings having construction without any obstructions.

b) The above shall not be applicable to those sprinklers which are recessed, concealed or flush with ceiling.

c) Various provisions under **9.10** shall be applicable to EC sprinklers also for location and orientation of deflectors with respect to possible obstructions due to structural elements.

d) Sprinkler location with respect to obstructions (to discharge) for upright and pendent sprinklers shall comply with the provisions Table 15 (*see also* Figs. 5, 6 and 7).

e) The clearance between the deflector and the top of storage (in case of storage block) shall not be less than 450 mm.

f) Deflectors of sprinklers shall be aligned parallel to the ceilings or roofs.

Table 15 Position of Sprinkler Deflector to Avoid Obstruction to Discharge for EC Sprinklers

[*Clause* 9.20.6 (d)]

Sl No.	Distance (*A*) Between Sprinklers and the Obstruction on Side mm	Maximum Allowable Distance of (*B*) Deflector Above the Bottom of Obstruction mm
(1)	(2)	(3)
i)	Less than 300	0
ii)	More than 300 and less than 450	0
iii)	More than 450 and less than 600	25
iv)	More than 600 and less than 750	25
v)	More than 750 and less than 900	25
vi)	More than 900 and less than 1 050	80
vii)	More than 1 050 and less than 1 200	80
viii)	More than 1 200 and less than 1 350	125
ix)	More than 1 350 and less than 1 500	175
x)	More than 1 500 and less than 1 650	175
xi)	More than 1 650 and less than 1 800	175
xii)	More than 1 800 and less than 1 950	225
xiii)	More than 1 950 and less than 2 100	275
xiv)	More than 2 100 and less than 2 250	350
xv)	More than 2 250 and less than 2 400	350
xvi)	More than 2 400 and less than 2 550	375
xvii)	More than 2 550 and less than 2 700	425
xviii)	More than 2 700 and less than 2 850	475
xix)	More than 2 850 and less than 3 000	525

9.21 Large Drop Sprinklers

9.21.1 *Protection Area*

a) Protection area of coverage shall be as indicated below:

    1) Building with non-combustible construction : 12 m^2
    2) Buildings with combustible construction : 9 m^2
    3) Rack Storage : 9 m^2

b) Maximum protection area shall not exceed 12.9 m^2 and minimum allowable protection shall not be less than 7.5 m^2.

9.21.2 *Maximum Distance Between Sprinklers*

The maximum distance between sprinklers shall be as follows:

a) Building with non-combustible construction : 3.7 m
b) Buildings with combustible construction : 3.0 m
c) Rack Storage : 3.0 m

9.21.3 *Minimum Distance Between Sprinklers*

Sprinklers shall be spaced not less than 2.4 m centre-to-centre.

9.21.4 *Maximum Distance from Walls*

The distance from sprinklers to walls shall not exceed one-half of the allowable distance as stated in **9.21.2** above.

9.21.5 *Minimum Distance from Walls*

Sprinklers shall be located at a minimum of 100 mm from a wall.

9.21.6 *Deflector Location and Orientation*

a) Distance between the sprinkler deflector and ceiling shall be minimum of 150 mm and maximum of 300 mm throughout the area of coverage of sprinkler protection for buildings having construction without any obstructions.
b) Deflectors of sprinklers shall be aligned parallel to the ceilings or roofs.
c) Sprinklers shall be so located as to minimize obstructions to discharge and where it is not possible, additional sprinklers shall need to be provided to ensure adequate coverage over the entire area.
d) Sprinkler location with respect to obstructions (to discharge) shall comply with the provisions in the following Table 16 (*see also* Fig. 7).
e) Various provisions under **9.10** shall be applicable to large drop sprinklers also for location and orientation of deflectors with respect to possible obstructions due to structural elements.
f) Where there are obstructions having width of less than 600 mm below the deflectors and the distance between the deflector and the bottom of obstruction is less than 600 mm, sprinklers shall be so located that the obstructions are centered between adjacent sprinklers.
g) Where conditions stated in (f) are not complied, additional sprinklers shall need to be provided below the obstructions.
h) At least 900 mm clearance shall be maintained between the deflector and the top of the storage.

Table 16 Position of Sprinkler Deflector to Avoid Obstruction to Discharge for LD Sprinklers (*see* Fig. 7)

[*Clauses* 9.21.6 (d) *and* 9.22.6 (c)]

Sl No.	Distance (*A*) Between Sprinklers and the Obstruction on Side mm	Maximum Allowable Distance (*B*) of Deflector Above the Bottom of Obstruction mm
(1)	(2)	(3)
i)	Less than 300	0
ii)	More than 300 less than 450	40
iii)	More than 450 less than 600	75
iv)	More than 600 less than 750	140
v)	More than 750 less than 900	200
vi)	More than 900 less than 1 100	250
vii)	More than 1 100 less than 1 200	375
viii)	More than 1 200 less than 1 400	450
ix)	More than 1 400 less than 1 500	450
x)	More than 1 500 less than 1 700	550
xi)	More than 1 700 less than 1 800	650
xii)	>1 800 mm	750

9.22 Early Suppression Fast Response (ESFR) Sprinklers

9.22.1 *Protection Area*

a) Protection area of coverage shall be as indicated below:
   1) Building with combustible construction : 9 m^2 (unobstructed)
   2) Building with non-combustible construction : 9 m^2

NOTE — ESFR sprinklers are permissible in buildings with combustible construction with/without obstructions.

b) Minimum protection area shall not be less than 5.9 m^2.
c) Where sprinklers need to be relocated due to obstructions from building elements, maximum protection area shall not be more than 10 m^2.

9.22.2 *Maximum Distance Between Sprinklers*

a) Maximum distance between sprinklers shall be as follows:
   1) For buildings having ceiling/roof height up to 9 m : 3.7 m
   2) For buildings having ceiling/roof height more than 9 m and up to 13.7 m : 3 m

b) Having no regard to the heights as stated above, sprinklers shall be permitted to be shifted by 0.3 m to avoid obstructions due to structural elements, provided the protection area does not exceed 10 m^2.

9.22.3 *Minimum Distance Between Sprinklers*

Sprinklers shall be spaced not less than 2.4 m centre-to-centre.

9.22.4 *Maximum Distance from Walls*

The distance from sprinklers to walls shall not exceed one-half of the allowable distance as stated in **9.22.2**.

9.22.5 *Minimum Distance from Walls*

Sprinklers shall be located a minimum of 100 mm from a wall.

9.22.6 *Deflector Orientation and Location*

a) Deflector orientation with respect to the ceiling/roof shall be as follows:
    1) Pendent sprinklers with K-factor of 200 and 240 shall be positioned so that the deflectors are a maximum of 350 mm and a minimum of 150 mm below the ceiling.
    2) Pendent sprinklers with K-factor of 320 and 360 shall be positioned so that the deflectors are a maximum of 450 mm and a minimum of 150 mm below the ceiling.
    3) Upright sprinklers with K-factor of 200 and 240 shall be positioned so that the deflectors are a maximum of 300 mm and a minimum of 75 mm below the ceiling.
b) Deflectors of sprinklers shall be aligned parallel to the ceilings or roofs when slopes of the ceiling exceed 1 in 6 (9°).
c) Sprinklers shall be so located as to minimize obstructions to discharge and where it is not possible; sprinkler location with respect to obstructions (to discharge) shall comply with the provisions in Table 16 (*see also* Fig. 7).
d) Sprinklers shall be fitted below the ducts, pipes, conveyors and the like under the following circumstances:
    1) rectangular and more than 0.8 m wide and less than 150 mm from the adjacent walls or partitions.
    2) circular and more than 1 m in diameter and less than 150 mm from the adjacent walls or partitions.
    3) rectangular and more than 1 m in width.
    4) circular and more than 1 m in diameter.
e) At least 900 mm clearance shall be maintained between the deflector and the top of the storage.

9.22.7 Where draught or smoke curtains are fitted at the ceiling level, forming bays, the draught or smoke curtain shall be treated as a boundary and sprinklers shall be located accordingly.

9.22.8 Where ESFR sprinkler protection adjoins areas protected by standard sprinklers, the following measures shall be complied with:

a) Where ESFR and the adjacent standard sprinklers are at the same ceiling height or where ESFR sprinklers are installed at a greater ceiling height than standard sprinklers, smoke curtains shall be installed at the ceiling separating ESFR and standard sprinklers. The smoke curtains shall be at least 600 mm deep and shall be located at the mid-point between the ESFR and standard sprinklers. The smoke curtain shall be made of non-combustible material.
b) An aisle 1.2 m wide, free of all stored goods, shall be maintained between ESFR protected areas and those protected by standard sprinklers. The centre of the aisle shall coincide with the mid-point between the ESFR and standard sprinklers.

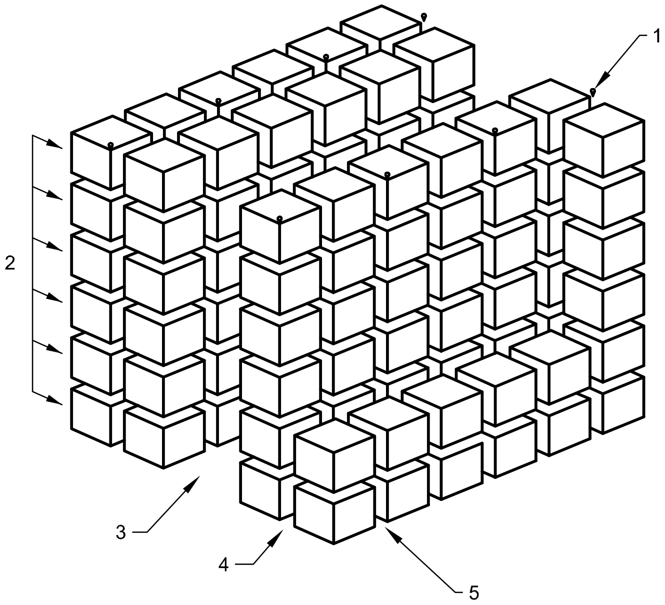
9.22.9 Range pipes shall not exceed 100 mm in size.

9.22.10 *Other Important Requirements for ESFR Installation*

a) ESFR sprinkler installations shall be accepted only for buildings where the slope of the roof is less than or equal to 9°. Where the roof slope exceeds 9°, ESFR sprinklers shall be used below a firmly secured false ceiling, only if the latter has a slope of less than 9° and is built with non-combustible construction. Concealed space shall be protected with standard sprinklers if required (*see* **9.10.5**).
b) ESFR sprinkler installation shall be used only on wet-pipe systems.
c) Annex C shall be used for the protection of high challenge storage areas by ESFR sprinklers.

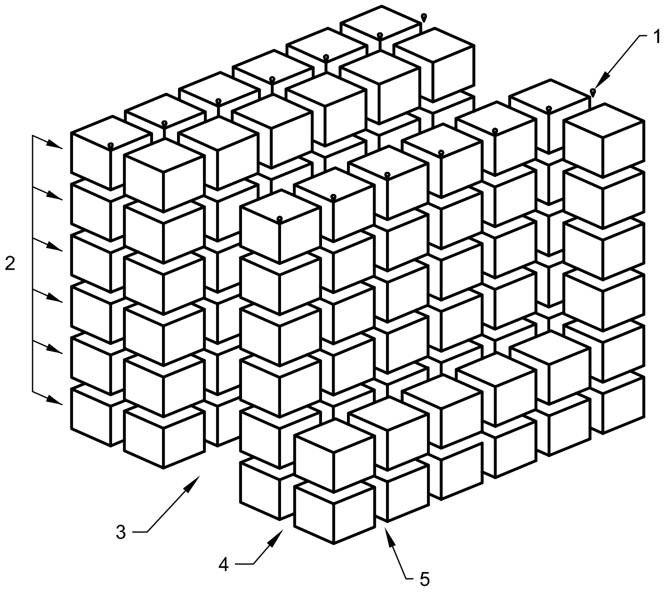
9.23 Intermediate or In-rack Sprinklers (*see* Fig. 10A and 10B)

a) The area protected by a single system of sprinklers shall not exceed 3 700 m^2 of floor area occupied by the racks, including aisles, regardless of the number of levels of in-rack sprinklers.
b) For high hazard storage in racks, shelves, etc, and protection by rows of intermediate sprinklers is mandatory, if storage heights are beyond 4 m. The requirements for the above provisions are as under:
c) The location of sprinklers shall be such that they are not obstructed by racks or structural steel work and as far as possible, they are in the path of longitudinal flue space. The discharge of



KEY
1. SPRINKLER ROW
2. TIERS
3. AISLE
4. LONGITUDINAL FLUE
5. TRANSVERSE FLUE

10A FOR CATEGORY I & II MATERIALS



KEY
1. SPRINKLER ROW
2. TIERS
3. AISLE
4. LONGITUDINAL FLUE
5. TRANSVERSE FLUE

10B FOR CATEGORY III & IV MATERIALS

FIG. 10 TYPCIAL DEPICTION OF IN-RACK SPRINKLERS

water shall be able to penetrate the goods stored in the racks. The clearance between the sprinkler deflectors and the stored goods shall not be less than 150 mm anywhere. The numbers of rows are determined by the height of the racks and/or shelves.

d) The horizontal spacing (longitudinal) between sprinklers shall not exceed 3.5 m for category I/II goods and 1.8 m for category III/IV goods. Laterally for every 3 m width of the racks (including two racks when stored back-to-back), there shall be one sprinkler.

e) The vertical spacing between sprinklers shall not exceed 3 m. If the top tier of the racks is within 3 m of the roof sprinklers, top tier need not be protected with intermediate sprinklers.

f) The location of intermediate sprinklers shall be such that the product of the horizontal and vertical spacing between sprinklers is not more than 9 m^2 for category I/II storage goods and 5 m^2 for category III/IV storage goods.

g) The design density for the roof or ceiling sprinklers shall be a minimum of 10 lpm/m^2 over an area of operation of 260 m^2 in case of intermediate sprinkler protection.

h) Where more than 50 intermediate level sprinklers are installed in the racks, they shall not be fed from the same control valve set as the roof or ceiling sprinklers.

j) In-rack sprinklers and the associated ceiling sprinklers shall always be fully calculated.

k) For the purposes of hydraulic calculation, it shall be assumed that 3 sprinklers are operating simultaneously at the most hydraulically remote position on each level of in-rack sprinklers, up to a maximum of three levels. Where rack aisles are 2.4 m or more in width only one rack need be assumed to be involved. Where rack aisles are less than 2.4 m but greater than or equal to 1.2 m in width, two racks shall be assumed to be involved. Where rack aisles are less than 1.2 m in width, three racks shall be assumed to be involved.

   NOTE — It is not necessary to assume simultaneous operation of more than three rows of sprinklers in the vertical plane nor more than three rows of sprinklers in the horizontal plane.

m) The minimum and maximum pressures at any operating sprinkler shall be as per **10.5.7** and **10.5.8**.

9.24 Sprinkler Protection for Specific Areas and Hazards

9.24.1 *Film and Television Production Studios*

Sprinklers shall be fitted under solid or slotted platforms (except those used for temporary platforms, etc, for sets but including those for lighting and other equipment) if these are more than 0.8 m wide and also for walkways, connecting stairs including those used for lighting and other equipment. Sprinklers shall also be fitted in concealed spaces or cavities more than 100 mm deep between combustible linings and walls/roofs.

9.24.2 *Theatres and Similar Premises*

In addition to the sprinklers in the roof or ceiling, sprinklers shall be fitted under the grid, the flies, the stage and any other obstruction to the discharge from the roof or ceiling sprinklers. Care shall be exercised in siting the sprinklers and associated pipework in case where moving sets are involved and also where personnel have to work in the close proximity of the sprinklers.

9.24.3 *Electronic Data Processing, Telephone Exchanges and Similar Areas*

Sprinkler protection shall comply with various provisions contained in IS 12456.

Pre-action sprinkler installation is recommended for above type of risks keeping in mind the effect of water discharge on such risks. *See also* Annex D.

9.24.4 *Lifts, Hoistways and Machine Rooms*

a) Side wall sprinklers shall be installed at the bottom of each lift hoist way at not more than 600 mm above the floor of the pit. However, for enclosed non-combustible lift shafts that do not contain combustible hydraulic liquids, sprinklers shall not be required.

b) For lift machine room at the top of the hoist way, temperature rating shall not be less than 57° and not more than 107° and sprinklers shall be either pendent or upright or sidewall type.

c) Sprinklers shall be installed at the top and bottom of lift hoist ways where lift use polyurethane coated steel belts or similar combustible belt material.

   NOTE — The sprinklers in the pit are intended to protect against fires caused by debris, which can accumulate over time. Ideally, the sprinklers should be located near the side of the pit below the lift doors, where most debris accumulate. However, care should be taken that the sprinkler location does not interfere with the lift toe guard, which extends below the face of the door opening.

9.24.5 *Closets and Pantries*

Sprinklers shall be provided inside closets and pantries, normally and found in residential and hotel occupancies, under following conditions:

a) Area contained is more than 2.5 m^2.

b) Short dimension is more than 1 m.

c) Walls and ceilings within are surfaced with combustible materials.

9.24.6 *Duct Protection*

a) Ducts shall have one sprinkler located at the top of each vertical riser and also at the mid-point of each offset.

b) Sprinklers shall not be required in vertical riser located outside the building at more than 7.5 m from the hood outlet.

c) Horizontal exhaust ducts shall have sprinklers located every 3 m, starting from 1.5 m from the duct entrance.

d) Sprinklers in exhaust ducts shall be protected against freezing.

e) Sprinklers inside the ducts shall be accessible for inspection, testing and maintenance.

NOTE — Reference is invited to **6.2.3** and **6.2.4** regarding sprinkler protection for certain specific areas like electric panels, DG sets, battery room, UPS units, etc when situated within a sprinklered occupancy.

10 PHILOSOPHY OF PIPE SIZING AND DESIGN

10.1 General Requirements

a) The nominal size of supply trunk mains and branch mains shall be not less than the size of any installation main distribution pipe, at its main installation control valve, supplied by the trunk main.

b) Individual sprinklers shall not be connected directly to distribution and main distribution pipes, except in the case of light-hazard installations where sprinkler may be connected directly to pipes not exceeding 50 mm nominal bore.

c) In ordinary or high-hazard installations arm pipes or drop pipes not exceeding 32 mm nominal bore shall be used to connect individual sprinklers where these are fed from pipes larger than 65 mm nominal bore.

d) In occupancies like offices, residences, hotels, etc which are normally divided into several rooms separated by corridors, minimum 32 mm pipes shall be used to cater sprinklers inside rooms.

e) Where upright or pendent conventional or spray sprinklers are fitted within 400 mm of the pipe axis alongside a pipe of nominal size greater than 65 mm, the deflector shall be not more than the appropriate distance given in Table 14 above the lower edge of the pipe.

f) Minimum pipe size for installation in any hazard shall be 25 mm nominal bore.

g) Range pipe size shall not exceed 50 mm nominal bore.

h) Number of sprinklers in a range pipe shall not exceed 6 (9 in case of range pipes having 50 mm diameter) (*see* Table 20).

j) Range pipes shall only be connected to the top of distribution pipes.

10.2 Protection of Concealed Space

10.2.1 Where there are concealed spaces above ceilings or below floors, and where the space below the ceiling or above the floor is classified as ordinary or high-hazard for which protection is specified in **10.2.2**, the concealed spaces shall be protected as follows:

a) If the height of the concealed space at roof and floor is no greater than 0.8 m, the spaces shall be sprinkler protected only if they contain combustible materials or are constructed with combustible materials. Electrical cables with voltage less than 250 V, single phase, with a maximum of 15 cables per tray, are allowed.

b) Otherwise the requirements shall be as specified for ordinary hazard.

10.2.2 The feed to the concealed space above or below the working space shall be arranged and sized as follows:

a) *Light Hazard* — The concealed space above or below shall be protected by a separate pipe from the installation valve.

b) *Ordinary Hazard* — If the concealed space above working space is fed individually from the pipework below, the range and distribution pipes in the installation shall be sized by taking the room and concealed space sprinklers cumulatively. Alternatively, if two feed pipes are used, one for the concealed space and one for the room sprinklers, the common feed pipe shall have a nominal bore of not less than 65 mm.

c) The concealed space below working space shall be fed by two feed pipes, one for the concealed space and one for the sprinklers in working space, the common feed pipe shall have a nominal bore of not less than 65 mm.

10.3 Pipe Sizing

10.3.1 Pipe sizes shall be determined using one of the following methods:

a) Pre-calculated system (except where gridded or looped layouts are used) is applicable only where light and ordinary occupancies where the aggregate floor plate area (in one or more floors combined) is 5 000 m^2 or less. *See also* notes under **4.4.2**.

b) Fully calculated system.

NOTE — Where manual calculations are tedious for large system and where complicated systems having numerous junction points and range pipes with differing layouts, the advantages of computer and software programs in design/validating should be considered.

10.3.2 Pipe sizes for the occupancies not covered under item **10.3.1** shall be determined by a fully calculated system such as by employing computer tools or software program.

a) Light and ordinary occupancies where the aggregate floor plate area (in one or more floors combined) exceeds 5 000 m^2.

b) High hazard occupancies,

c) Storage occupancies, and

d) All occupancies where conventional and special sprinklers are used like ESFR, LD, EC, intermediate, etc.

10.3.3 Minimum pressures for various applications shall be as stipulated in **10.5.7** and also in Annex C; but maximum pressure in the installation shall not exceed 7 bar.

10.4 Pre-calculated Pipe Sizing

10.4.1 *General*

a) Pipe sizes shall be determined partly from the appropriate tables and partly by hydraulic calculation. Pipe diameters shall not increase in the direction of flow of water to any sprinkler.

b) The size of all pipes upstream of each design point shall be calculated as specified in **10.4.3** (e) for light hazard and **10.4.4** (b) for ordinary hazard.

c) Risers and drops connecting distribution pipes to ranges, and pipes connecting single sprinklers, other than arm pipes, shall be considered as distribution pipes and sized accordingly.

10.4.2 *Design Points and their Locations*

a) The design point shall be at the point of connection of a horizontal distribution pipe to one of the following:

    1) a range pipe caters to one or more sprinklers;

    2) a riser or drop connecting ranges to distribution pipes; and

    3) a pipe feeding a single sprinkler.

b) The maximum number of sprinklers downstream of each design point shall be as specified in Tables 17 and 18 for light and ordinary hazard occupancies, respectively. *See also* Fig. 11 and Fig. 12, respectively.

Table 17 Light Hazard – Location of Design Point

[*Clause* 10.4.2 (b)]

Hazard Class (1)	Number of Sprinkler in a Range Pipe (2)	Location of Design Point Downstream of nth Sprinkler where n is (3)
Light	≤ 3	3
	≥ 4	4

Table 18 Ordinary Hazard – Location of Design Point

[*Clause* 10.4.2 (b)]

Sl No. (1)	Hazard Class (2)	Number of Sprinklers on a Distribution Pipe (3)	Location of Design Point on a Distribution Pipe Junction to a Range holding nth Sprinkler where n is (4)	Type of Range Pipe Layout (5)
i)	Ordinary	>16	17	Two end - side
ii)	Ordinary	>18	19	All others

c) In light hazard installations the design point shall be downstream of the sprinkler identified in col 3 of Table 17.

d) In ordinary hazard installations the design point shall be downstream of the junction of distribution pipes and range pipes in accordance with col 4 of Table 18.

e) Where the number of sprinklers on one array, in a room or on a single distribution pipe, is less than or equal to the number of sprinklers for which the distribution pipes are designed (*see* col 3 of Table 18), the design point shall be downstream of the point of connection to the distribution pipe of the range or the array hydraulically nearest to the control valve set.

f) Different types of layouts are shown in Fig. 3.

10.4.3 *Light Hazard Installation*

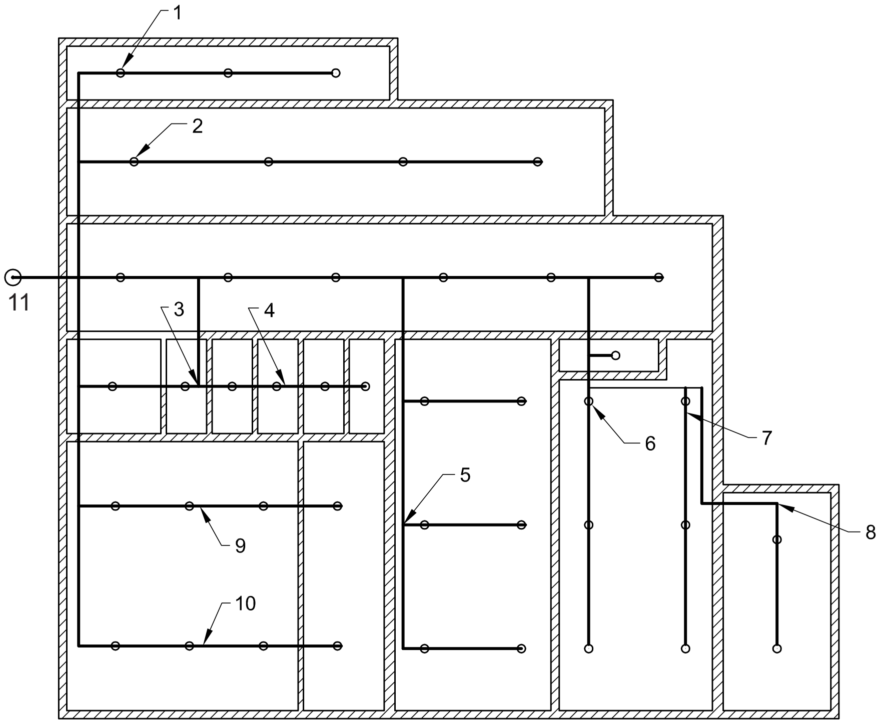
a) The size of range pipes, and terminal distribution pipes downstream of the design point shall be at least 25 mm with a maximum of 3 sprinklers on range pipes (*see* Fig. 11).

b) If there are only two sprinklers in a room, 25 mm pipe shall not be installed between the 3rd and 4th sprinkler.

c) All pipe work between the control valve set and the design point at each extremity of an array shall be sized by hydraulic calculation using the values in Table 19.

d) If there are more than two sprinklers on a range pipe, the pressure loss between the 2-sprinkler point and the distribution pipe shall be determined by using the pressure loss given in col 3 of Table 19. The pressure loss in the distribution pipe between this connection and the control valve sets shall be determined by the pressure loss per metre given in col 4 of Table 19.

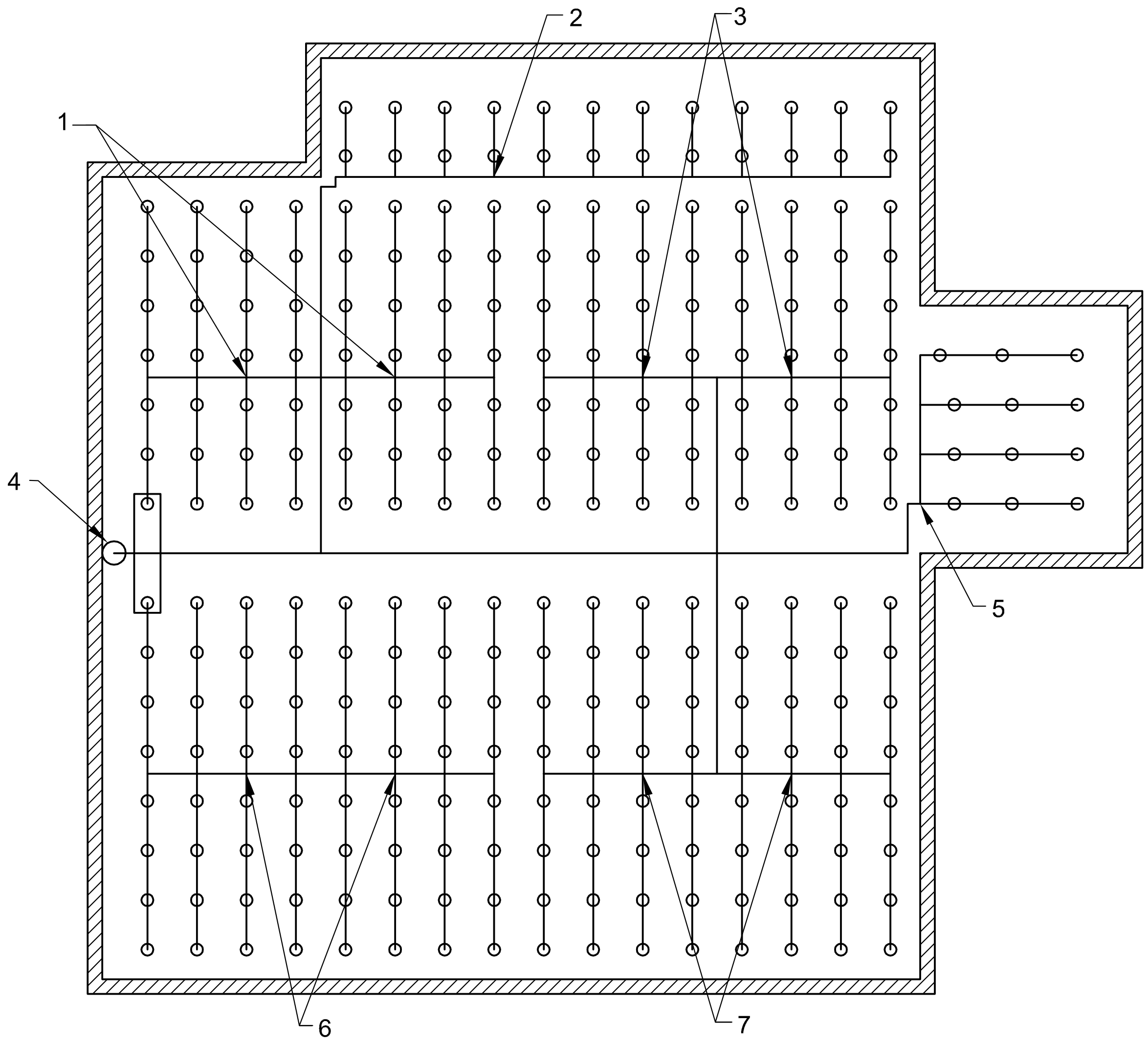
e) The pipe diameters between the design point in the most remote area of the installation and the control valve set shall be calculated to ensure that the total pressure loss due to friction with a flow of 225 litre/min does not exceed 0.7 bar.



KEY :

1 2-SUPPLY POINT
2 3-SUPPLY POINT
3, 4, 5, 6,7, 8, 9, 10 2-SUPPLY POINT
11 SUPPLY POINT

FIG. 11 DESIGN POINT – LIGHT HAZARD INSTALLATION



KEY :

1, 2, 3, 5, 6 AND 7 - DESIGN POINTS
4 - CONTROL VALVE SET

Fig. 12 Design Point – Ordinary Hazard Installation (Typical)

In buildings with more than one floor, or where there are a number of different levels, for example, platforms or mezzanines, the 0.7 bar loss in pressure from the design point may be increased by an amount equivalent to the static pressure due to the height difference between the highest sprinkler point in the building and the remote area design point on the floor concerned.

Table 19 Pressure Loss for Design Flow Rates in Light Hazard Installations

[*Clause* 10.4.3 (c) *and* (d)]

Sl No.	**Pipe Diameter** mm	**Loss of Pressure in Pipe** milli bar/metre	
		Flow is 100 lpm	Flow is 225 lpm
(1)	(2)	(3)	(4)
i)	25	44	200
ii)	32	12	52
iii)	40	5.5	25
iv)	50	1.7	8
v)	65	0.45	2

10.4.4 *Ordinary Hazard Installation*

a) The size of range pipes downstream of the design point shall be as specified in Table 20 (*see* Fig. 12). For distribution pipes, *see* Table 21.

b) The pipe diameters between the design point in the most remote area of the installation and the control valve set shall be calculated to ensure that the total pressure loss due to friction with a flow of 1 000 litre/min does not exceed 0.5 bar.

In buildings with more than one floor, or where there are a number of different levels, for example, platforms or lean-to's, the 0.5 bar loss in pressure from the design point may be increased by an amount equivalent to the static pressure due to the height difference between the highest sprinkler point in the building and the remote area design point on the floor concerned.

10.4.5 *Pressure and Flow Requirements for Pre-calculated Systems (Light and Ordinary Hazard Installations*

a) The water supply shall be capable of providing not less than the appropriate flows and pressures specified in Table 22 at each installation control valves. The pressure loss due to friction and static head between the water supply and each control valve set shall be calculated separately.

b) Orifice plates, if required, shall be used to balance the pressures at each design point in the network in case of bigger network and also where the network is distributed through upper floors.

Table 20 Sizing of Range Pipes in Ordinary Hazard Installations

[*Clauses* 10.1 (h) *and* 10.4.4 (a)]

Sl No.	**Range Pipes**	**Type of Layout**	**Diameter** mm	**Maximum Number of Sprinklers Fed**
(1)	(2)	(3)	(4)	(5)
i)	Ranges at remote end of all distribution pipes – last two ranges	2 end-side layouts	25	1
			32	2
ii)	Last three ranges	3 end-side layouts	25	2
			32	3
iii)	Last range	All other layouts	25	2
			32	3
			40	4
			50	9
iv)	All other ranges	All Pipes	25	3
			32	4
			40	6
			50	9

Table 21 Sizing of Distribution Pipes in Ordinary Hazard installations

[*Clause* 10.4.4 (a)]

Sl No.	**Distribution Pipes**	**Type of Layout**	**Diameter** mm	**Maximum Number of Sprinklers Fed**
(1)	(2)	(3)	(4)	(5)
i)	At extremities of the installation	2 end-side layouts	32	2
			40	4
			50	8
			65	16
ii)	Last three ranges	All others	32	3
			40	6
			50	9
			65	18
iii)	Between design points and the installation valves	All	To be calculated as per **10.4.4** (b)	

Table 22 Pressure and Flow Requirements for Pre-calculated LH and OH Systems

[*Clause* 10.4.5 (a)]

Sl No.	**Hazard Class**	**Flow** lpm	**Pressure at Installation Valve** bar	**Maximum Demand Flow** lpm	**Pressure at Installation Valve** bar
(1)	(2)	(3)	(4)	(5)	(6)
i)	Light	225	2.2 + static losses if any	–	–
ii)	Ordinary	1800	2.02 + static losses if any	2 100	1.5 + static losses if any

10.4.6 *Documents to be Submitted for Pre-calculated Pipework*

For pre-calculated pipework the following details shall be submitted along with layout drawings of the sprinkler installation:

a) Identification of the design point of each array on the layout drawing (*see* Fig. 11 and Fig. 12 for example).

b) Summary of the pressure losses between the control valve set and the design points at the following design rates of flow:

   1) In an LH installation – 225 litre/min
   2) In an OH installation – 1 000 litre/min

c) The calculation as specified in **10.4.1**, showing that:

   In LH and OH installations, for each run of distribution pipework, $P_f - P_h$ is no more than the appropriate value specified in **10.4.3** or **10.4.4** respectively, where, P_f is the frictional pressure loss in the distribution pipework between the design point and the control valve 'C' gauge, in bar, and P_h is the static pressure between the level of the highest design point on the floor concerned and the level of the highest design point in the top storey, in bar.

10.5 Fully Calculated Systems

10.5.1 For fully calculated pipe work, the following details shall be submitted, with detailed sheets or as a computer printout:

a) The program name and version number.

b) The date of the worksheet or print-out.

c) The actual internal diameters of all pipes used in the calculation.

d) For each design area of operation:

   1) The area identification.
   2) The hazard class.
   3) The specified design density, in lpm/m^2.
   4) The assumed maximum area of operation (area of operation), in m^2.
   5) The number of sprinklers in the area of operation.
   6) The sprinkler nominal orifice size, in mm.
   7) The maximum area covered per sprinkler, in m^2.
   8) Detailed and dimensioned working drawings showing the following:
      i) Node or pipe reference scheme used to identify pipes and, junctions.
      ii) Sprinkler heads and fittings which need hydraulic consideration.
      iii) Position of the hydraulically most favourable area of operation.
      iv) Number of sprinklers upon which the design density is based.
      v) Height above datum of each point of identified pressure value.

e) For each operating sprinkler:

   1) The sprinkler node or reference number.
   2) The nominal K-factor.
   3) The flow through the sprinkler, in lpm.
   4) The inlet pressure to the sprinkler or sprinkler assembly, in bar.

f) For each hydraulically significant pipe:

   1) Pipe node or other reference number.
   2) Nominal bore, in mm.
   3) The Hazen-Williams constant.
   4) Flow, in litre/min.
   5) Velocity, in m/s.
   6) Length, in m.
   7) Numbers, types and equivalent length in metres of fittings and components.
   8) Static head change, in m.
   9) Pressures at inlet and outlet, in bar.
   10) Friction loss, in bar.
   11) Indication of flow direction.

g) A pressure/flow characteristic graph indicating the available pressure at any flow up to the maximum flow demand.

h) The demand pressure/flow characteristic graph for each installation for the hydraulically most unfavourable (and if required the most favourable) area of operation with pressure taken as at the control valve 'C' pressure gauge (*see* IS 3624).

10.5.2 *Calculation of Pressure Losses in Pipework*

a) Calculations of pipe friction loss shall be not less than those derived from the Hazen-Williams formula:

$$P_L = \frac{(6.05 \times 10^5) \times L \times Q^{1.85}}{(C^{1.85} \times D^{4.87})}$$

where

P_L = pressure loss in pipe (bar),

Q = flow through the pipe (lpm),

D = nominal internal diameter of the pipe (mm),

C = constant for the type and condition of pipe (*see* Table 23), and

L = equivalent length of pipe and fittings (m).

Values of C for different types of pipe is as shown in the Table 23.

b) Static pressure difference is expressed as:

$$P_s = 0.098H$$

where

P_S = static pressure difference (bar), and

H = the vertical distance between the points (m).

Attention is drawn to **10.3.3** with regard to pressure limitations within the sprinkler installation.

Table 23 C-Values for Various Types of Pipe

[*Clause* 10.5.2 (a)]

Sl No. (1)	Type of Pipe (2)	C-Value (3)
i)	Cast iron	100
ii)	Ductile iron	110
iii)	Mild steel, galvanized steel	120
iv)	Spun cement, cement lined cast iron	130
v)	Stainless steel, reinforced glass fibre, concrete	140
vi)	Plastic (all types)	150

10.5.3 *Velocity in the Pipework*

The maximum allowable velocity is as follows:

a) 6 m/s - through any valve, flow monitoring device or/and strainer.

b) 10 m/s at any other point in the system.

NOTE — Above should be under the stabilized flow condition at the demanding point with total number of sprinklers assumed to be simultaneously in operation.

10.5.4 *Pressure Loss Through Fittings and Valves*

a) The pressure loss due to friction in valves, and in fittings where the direction of water flow is changed through 45° or more, shall be calculated using the formula specified in **10.5.2**. The appropriate equivalent length shall be as indicated in Tables 24 and 25.

The equivalent length for sizes smaller than 50 mm is provided in the Table 25 and for 50 mm or more are provided in Table 24.

b) *Accuracy of Calculations* — Hydraulic calculations shall be carried out in the units and with the accuracy given in Table 26.

c) The calculations shall balance as follows:

   1) The algebraic sum of pressure loss shall equal 0 ± 1 mBar; where water flows join at a junction, the calculation shall balance to ± 1 mBar.

   2) The algebraic sum of water flow at a junction shall be equal 0 ± 0.1 lpm.

10.5.5 *Design Area and Adjustment of Design Area for Various Types of Sprinklers Used in the Network*

Attention is drawn to **8.2** and **8.3** in design density of application, **8**.

10.5.6 *Other Requirements*

a) For sloped ceiling applications, design area for density application shall be based on projected horizontal area.

b) Each sprinkler in the design area and the remainder of the fully calculated system shall discharge at a flow rate at least equal to the stipulated minimum water application rate multiplied by the design area.

c) Where sprinklers are required to discharge a specific flow or pressure rather than density, each sprinkler in the design area shall discharge at a flow or pressure at least equal to the minimum required.

d) Calculations shall begin at the hydraulically most remote sprinkler.

e) The calculated pressure at each sprinkler shall be used to determine the flow rate of that particular sprinkler.

f) Pipe diameters on the installation side of the control valve set may decrease only in the direction of water flow, except in the case of grid and loop configurations.

g) Upright sprinklers shall not be connected to any pipe with a diameter greater than 65 mm. Pendent sprinklers shall not be directly connected to any pipe with a diameter greater than 80 mm. For larger diameters, an arm pipe shall be fitted so that the distance from the sprinkler deflector to the edge of the main pipe is not less than 1.5 times the diameter of this pipe.

Table 24 Equivalent Length of Fittings and Valves

[*Clause* 10.5.4 (a)]

Sl No.	Fittings and Valves	Equivalent Length of Medium Grade Steel Pipe (in m) According to IS 1239 (Part 1) (C = 120) for Diameter in mm equal to						
		50	65	80	100	150	200	250
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Screwed elbow 90°	1.46	1.89	2.37	3.04	4.30	5.67	7.42
ii)	Welded elbow 90°	0.69	0.88	1.10	1.43	2.00	2.64	3.35
iii)	Screwed elbow 45°	0.76	1.02	1.27	1.61	2.30	3.05	3.89
iv)	All other fittings	2.91	3.81	4.75	6.10	8.61	11.34	13.85
v)	Gate valve	0.38	0.51	0.63	0.81	1.13	1.50	1.97
vi)	Alarm valve and N.R valve	–	–	3.94	5.07	7.17	9.40	12.30
vii)	Alarm valve and N.R valve (Mush room)	–	–	119.71	5.36	35.88	47.27	61.85
viii)	Butterfly valve	2.19	2.86	3.55	4.56	6.38	8.62	9.90
ix)	Globe valve	6.43	21.64	126.80	34.48	48.79	64.29	84.11

NOTE — The equivalent lengths can be converted as necessary for pipes with other *C* values by multiplying the above values by following factors:

100	110	120	130	140	150
0.714	0.85	1	1.16	1.33	1.51

Table 25 Equivalent Length of Fittings and Valves

[*Clause* 10.5.4 (a)]

Sl No.	Fittings	Equivalent Length (in m) of Medium Grade Steel Pipe (in m) According to IS 1239 (Part 1) (C = 120) for Diameter in mm equal to		
		25	32	40
(1)	(2)	(3)	(4)	(5)
i)	Screwed elbow 90°	0.77[1)]	1.04	1.22
ii)	Welded elbow 90°	0.36[1)]	0.49	0.56
iii)	Screwed elbow 45°	0.40[1)]	0.55	0.66
iv)	All other fittings	1.54	2.13	2.44

[1)] It is strongly advised to avoid 25 mm sized elbows in the installation.

Table 26 Accuracy of Hydraulic Calculations

[*Clause* 10.5.4 (b)]

Sl No.	Quantity	Unit	Accurate to
(1)	(2)	(3)	(4)
i)	Length	m	0.01
ii)	Height	m	0.01
iii)	Equivalent length	m	0.01
iv)	Flow	lpm	1.00
v)	Pressure loss	mBar/m	1.00
vi)	Pressure	mBar	1.00
vii)	Velocity	m/s	0.10
viii)	Area	m^2	0.01
ix)	Density of water application	lpm/m^2	0 – 10

10.5.7 *Minimum Sprinkler Discharge Pressure*

The pressure at the hydraulically most unfavorably situated sprinkler, when all the sprinklers in the area of operation are in operation, shall be not less than that required to achieve the density specified in **8** or the following, whichever is the higher:

a) 0.7 bar for light hazard.
b) 0.5 bar for ordinary hazard.
c) 0.5 bar for high hazard (process and storage).
d) 1.00 bar for intermediate sprinkler with K-115.
e) 2.00 bars for intermediate sprinklers K-80.

NOTE — Where a higher minimum operating pressure for the desired application is specified in the rules, same shall take precedence (*see* **10.5.8**).

10.5.8 *Maximum Sprinkler Discharge Pressure*

For storage applications, higher pressures than what is stated in **10.5.7** will be required (*see* Annex C). Pressure at any sprinkler in such cases shall not exceed shall not exceed 7 bar (*see* **10.3.3**).

10.5.9 To avoid excessive build-up in pressures in piping closer to the installation valves, pipe network shall be designed on the basis of layout shown in **10.3** with more distribution pipes feeding pockets of range arrays. For large installations, pressure balancing shall be done if required, by insertion of either local orifice plates or pressure reducing stations in order to avoid excessive pressures in hydraulically favourable locations.

11 COMPONENTS OF SPRINKLER INSTALLATION

11.1 Piping

For a sprinkler system to perform properly during a fire, the network of piping that delivers water from its source to the open sprinklers must be capable of withstanding both the internal pressure acting upon it and high external temperatures. In addition, the piping network must be properly supported and able to maintain its structural integrity during an earthquake. It must also be installed so it does not interfere with the sprinkler's water discharge. The requirements given below shall receive attention.

11.1.1 The pipe used in the sprinkler system (from the pump house to the installation control valves) shall be laid underground or in masonry culverts with removable covers of incombustible construction and shall be of any one of the following types:

a) Cast iron double flanged class 'A' pipes conforming to the following standards:
   1) Horizontally cast iron pipes : IS 7181
   2) Vertically cast iron pipes : IS 1537 [1]
   3) Centrifugally cast (spun) iron pipes : IS 1536

   [1] Where the nominal diameter of the pipe exceeds 300 mm and where the pump delivery pressure exceeds 7 bar, class B pipes would be necessary.

b) Spun Pipes
   1) Centrifugally cast (spun) iron pipes, class A: IS 1536 with rubber gasket joints
   2) Centrifugally cast (spun) ductile iron pipes: IS 8329
c) Wrought or mild steel pipes (galvanized) of heavy grade: IS/ISO 3183[1]
d) Wrought or mild steel pipes (non-galvanized) of heavy grade: IS 1239[2] and IS/ISO 3183
e) Electric resistance welded (ERW) steel pipes: IS 3589

[1] No welding is permissible.

[2] Welding permissible with butt-welded joints and coated and wrapped as per IS 10221. At least 10 percent of all the welded joints shall be radiographically tested and half of the joints radiographed shall be field joints. It is preferable if one flange joint is introduced after every three lengths of pipes, considering the ease of maintenance.

11.1.2 The pipe used in the sprinkler system (from the pump house to the installation control valves) may be laid above ground in case of piping materials as per **11.1.1** (c) to **11.1.1** (e) above with welded [except in case of **11.1.1**(c)], threaded or flanged joints subject to following conditions:

a) Pipes shall be laid in exclusive rolled steel section/steel supports and shall not run in pipe racks with other utility piping.
b) The external pipes shall be run at minimum distances from the buildings as stated below:

1)	Light hazard	: 6 m
2)	Ordinary hazard	: 6 m
3)	High hazard (including storage)	: 15 m

11.1.3 Pipes shall not be laid under buildings or plant areas or storage areas. As far as possible, pipes shall not be laid under large open storage, railroads and roads carrying heavy traffic.

11.1.4 Underground pipes shall be laid not less than 1 m (top of pipe) below ground level.

11.1.5 Underground pipes in case of materials in **11.1.1** (a), (b)(1) and (b)(2) shall be provided with masonry or equivalent supports and thrust blocks (where necessary) at regular intervals.

11.1.6 Where soil conditions are unsatisfactory, masonry or equivalent supports and shall be provided at regular intervals for all other pipes also.

11.1.7 Pipes shall not traverse on ground, which is not under the control of the owner of the installation. Pipes shall also not pass through public roadways.

11.1.8 The installation piping (from the pump house up to the installation control valve and also the installation piping with sprinklers above the installation control valve) shall be capable of withstanding for 120 min a pressure equivalent to 150 percent of the maximum working pressure.

11.1.9 All bolt holes in the flanges shall be drilled. Drilling of each flange shall be in accordance with the relevant Indian Standards.

11.1.10 Flanges shall be faced and have jointing of rubber insertions or asbestos compound.

11.1.11 Welded joints of any type shall not be permitted for pipes having diameter less than 50 mm.

11.1.12 It is not permissible to run the sprinkler pipes through an unsprinklered building or occupancy and where it is not practicable the supply pipeline shall be installed at ground level and enclosed in brick trenches covered with removable RCC precast slabs.

11.1.13 All installation pipework above ground shall be installed at a slope not less than 1 : 500 for horizontal run of pipes. Normally the pipework should slope through the installation valve. If the pipework is trapped (below the level of the installation valve for example in the basements), arrangements shall be made to provide drain cocks at the bottom of such pipes to drain the trapped water in full.

11.1.14 Sprinkler pipes shall not be embedded in concrete floors or ceilings of any building.

11.1.15 A single air vent shall be provided on each wet-pipe system. The vent shall be located near a high point in the system to allow air to be removed.

11.2 Fittings

11.2.1 Fittings installed underground shall be of cast iron heavy grade conforming to IS 1538 whereas those installed over ground shall be of heavy grade wrought or mild steel conforming to IS 1239 (Part 2) or malleable iron fittings conforming to IS 1879.

11.2.2 All fittings shall be able to withstand for 120 min at least a pressure of 150 percent of the maximum working.

11.2.3 Welded fittings according to the laid down welding procedure are permitted. Welded parts shall be galvanised or suitably coated after welding as per the requirement of the areas to be protected by the system, that is chemical and electrolytic corrosion.

11.2.4 Welded joints shall not be permitted for fittings of less than 50 mm diameter.

11.3 Joining of Piping and Fittings

11.3.1 *Threaded Pipes and Fittings*

a) All threaded pipes and fittings shall have threads cut to relevant Indian Standards.
b) Steel pipes with thicknesses less than schedule 30 (size 200 mm or more) and those of schedule 40 (size less than 200 mm) shall be permitted to be jointed only with threaded fittings.
c) Joint compound or tape shall be applied only to male threads.

11.3.2 *Welded Pipe and Fittings*

a) Pipes meant for sprinkler installation shall only be shop welded, unless permitted by the authorities or agencies responsible for approval of the sprinkler system.
b) Welding shall be done under supervision as per proper approved procedures through qualified welders. Necessary records shall be maintained with regard to work completed, defects observed, re-work and clearance, etc. Also details of radiography test for the welded pipes duly signed by the protocol shall be maintained.

11.3.3 *Groove Joining Methods*

a) Pipes joined with grooved couplings shall be joined by approved couplings, gaskets and groove dimensions.
b) Grooved connections of fittings and valves and grooves cut and rolled on pipe shall be dimensionally compatible with the couplings.

11.4 Pipe Supporting Methods (Above Installation Control Valve ICV)

11.4.1 *General*

a) Sprinkler pipes shall be supported from the building structure which itself shall be capable of supporting the water filled pipework and shall not impair the performance of sprinklers under fire conditions.
b) Pipework shall not be used to support any other loads except where primary support is designed for the suspension of the piped service.
c) Distribution/range pipes shall not be supported from ceiling sheathing or cladding or from any other associated suspension systems.
d) Pipes below obstructions such as ductwork shall be either supported from the building structure or from the steel members supporting such obstructions. Such members shall be capable of supporting the weight of water filled pipes too.
e) Hangers shall not be welded or fastened directly to the pipework. It shall be ensured that the building

structure can support the added minimum load. When pipe hangers are attached to a non-building structure, ensure the non-building structure design takes into account the load imposed by the sprinkler system piping.

f) The supports on which the pipework rests shall be secured firmly in position.

g) The thickness of all parts of pipe supports shall not be less than 3 mm.

h) Wherever possible, pipes shall be supported from non-combustible building elements.

j) Pipework in corrosive areas shall be of either stainless steel or suitably protected against corrosion.

k) The distance between the pipe supports measured along the line of connected pipes (whether the pipes run horizontally, vertically or at angles) shall not be less than the following Table 27.

Table 27 Spacing of Pipe Supports

[*Clause* 11.4.1 (k)]

Sl No.	Material	Diameter mm	Spacing m
(1)	(2)	(3)	(4)
i)	Steel	25	3.6
ii)		32 to 100	4.5
iii)		More than 100	6.0
iv)	CPVC	25, 32	1.8
v)		40, 50	2.1
vi)		65, 80	2.7
vii)		More than 80	Not applicable

11.4.2 *Distribution Pipes*

a) The first support on a nominally horizontal distribution pipe shall not be at more than 2 m from the main distribution pipe.

b) The last support on a nominally horizontal distribution pipe shall not be more than 450 mm from the end.

c) Drop or rise pipes shall be secured to the building structure either directly or indirectly at the adjacent nominally horizontal part of the pipe within 300 mm of the drop or rise.

11.4.3 *Range Pipes*

a) At least one support shall be provided for:
   1) each pipe run connecting adjacent sprinkler, and
   2) the pipe run connecting the distribution pipe and the first sprinkler on the range pipe.

b) Pipe supports shall not be closer than 150 mm to any sprinkler axial central line.

c) The first support on a range pipe shall not be more than 2 m from the distribution pipe.

d) The last support on a range pipe shall not be at more than 1.5 m from the range pipe end or where there is a horizontal arm pipe of 450 mm or longer, the arm pipe end or where there is a drop or rise exceeding 600 mm, the drop or rise pipe end.

11.4.4 Outgoing mains from the installation valve to the system shall be supported at every 3.5 m of its run.

11.4.5 The thickness of all components used in pipe supports shall not be less than 3 mm anywhere.

11.4.6 Some of the typical supporting arrangements are shown in Fig. 13.

11.5 Protection Against Fire and Mechanical Damage

a) Piping shall be installed in such a way that the pipes are not exposed to mechanical damage. Where pipes are installed above gangways with low headroom, or at intermediate levels, or in other similar situations, precautions shall be taken against mechanical damage.

b) Where it is unavoidable for water supply pipework to pass through a non-sprinklered building, it shall be installed at ground level and shall be enclosed to protect against mechanical damage, with appropriate fire resistance.

11.6 Painting

Non-galvanized ferrous pipework shall be painted if environmental conditions make it necessary. Galvanized piping shall be painted wherever the coating has been damaged, say by threading.

11.7 Drainage

See **11.9.4** for installation requirements of drain valves.

11.8 Other Type of Pipes and Fittings

11.8.1 *General*

a) Pipes other than that listed under **11.1.1** and **11.1.2** may also be used for sprinkler installation provided suitable standards are available for fabrication, testing and approval.

b) Fittings shall also be available of same material for such pipes and standards shall be available for fabrication, testing and approval.

c) Such pipes and fittings shall preferably bear 'ISI' mark.

d) Such pipes shall not be used for portions of any occupancy.

e) Such pipes shall be used for the specific purpose as defined in the standard and shall not be used beyond the purpose for which they are approved and licensed.

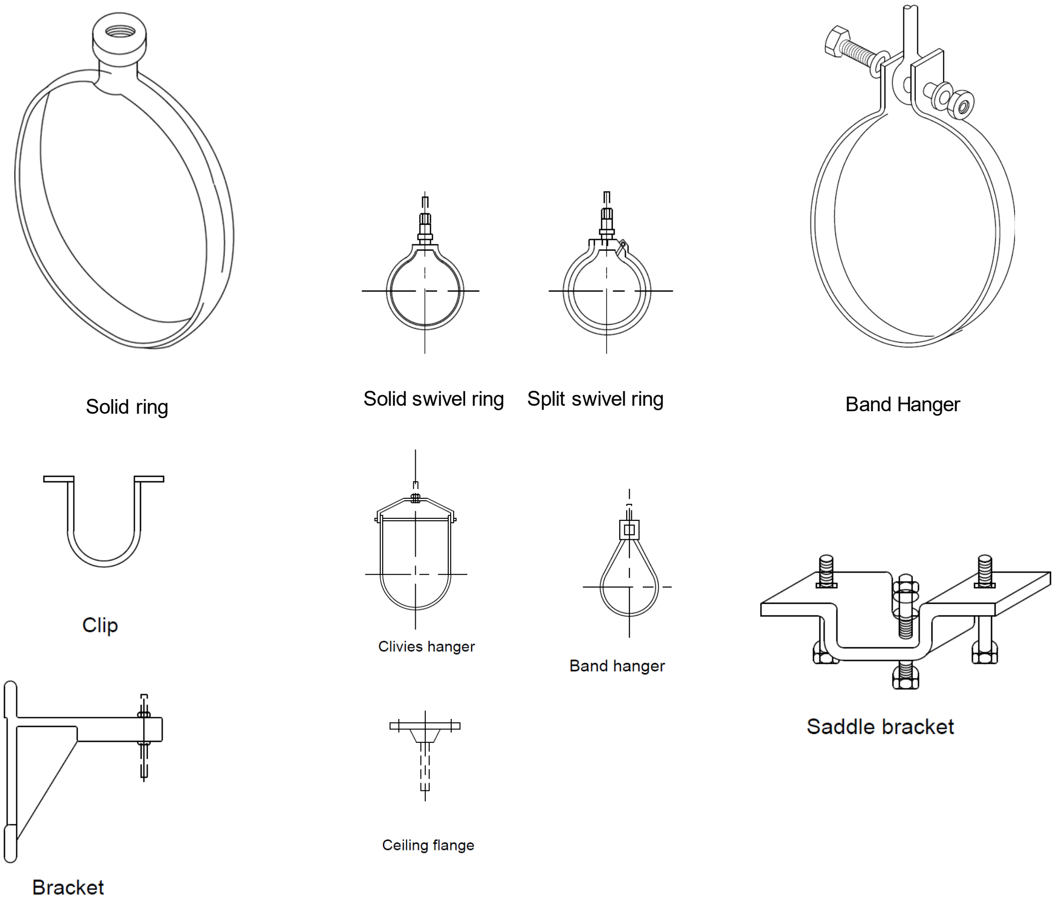

Solid ring
Solid swivel ring
Split swivel ring
Band Hanger
Clip
Clivies hanger
Band hanger
Saddle bracket
Bracket
Ceiling flange

FIG. 13 A

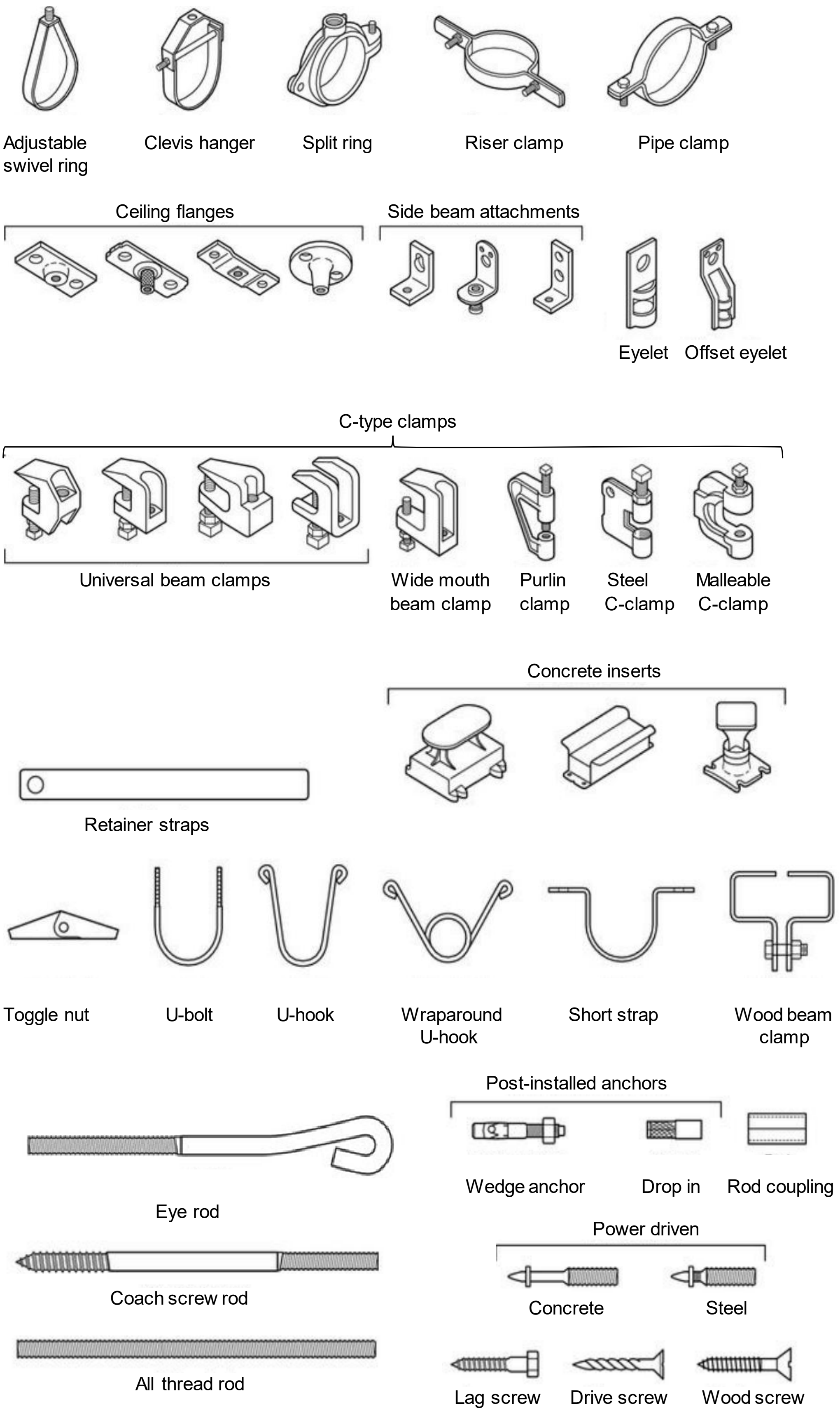


Fig. 13 B

FIG. 13 PIPE SUPPORT

11.8.2 *CPVC Pipes and Fittings*

11.8.2.1 CPVC plastic pipes accordance with following clauses shall be investigated for suitability in automatic sprinkler installations and approved for this service. Approved CPVC pipes shall be installed in accordance with its approval limitations, including installation instruction.

Before using CPVC pipes, the following factors shall be taken into consideration:

a) Pressure rating,
b) Beam strength (hangers),
c) Unsupported vertical stability,
d) Movement of pipes during sprinkler operation (affecting sprinkler pattern),
e) Corrosion (internal, external), chemical and electrolytic,
f) Resistance at elevated temperatures,
g) Joining methods (strength, permanence, fire exposure), and
h) Integrity during seismic movement.

11.8.2.2 CPVC pipes shall comply with IS 16088, bearing ISI mark and fittings shall comply with the IS 16534 with regard to its fabrication and installation and shall preferably bear ISI mark. Also usage of piping for installation in a building shall be investigated with regard to their installation and approvals.

11.8.2.3 When CPVC pipe is used in combination systems utilizing internally coated steel piping and CPVC piping, the steel pipe shall be investigated for compatibility with CPVC by a testing laboratory. Cutting oils and lubricants used for fabrication of the steel piping shall be compatible with CPVC materials.

11.8.2.4 When CPVC pipe is used in combination systems utilizing steel pipe that is not internally coated and CPVC piping, no additional evaluations are required. Cutting oils and lubricants use for fabrication of the steel piping shall be compatible with CPVC materials.

11.8.2.5 Fire stopping materials intended for use on CPVC piping penetrations shall be investigated for compatibility with CPVC materials.

11.8.2.6 Other construction materials, such as paint, electrical and communication wiring, thread sealants, gasket lubricant shall not come in contact with CPVC unless they have been evaluated as compatible with CPVC materials by a testing laboratory.

11.8.2.7 CPVC pipes can be used only for the following applications:

a) For light hazard occupancies (non-industrial) where the areas of any rooms, corridors, halls, etc are not more than 126 m^2 and are bounded by masonry/or RCC walls up to the roof and all openings therein protected as stipulated in **5.2.2**.
b) For ordinary hazard portions (of not exceeding 37 m^2) of occupancies which are incidental to the otherwise predominant light hazard occupancy.
c) For wet pipe installations.
d) For fully calculated pipework installations.
e) Installations employing quick-response sprinklers.
f) In ceiling voids where sprinkler protection is not required within the void.

11.8.2.8 CPVC pipes shall not be used for the following:

a) In spaces which are used as ventilation plenums.
b) In combustible concealed spaces.

11.8.2.9 Maximum pressure in the installation with CPVC pipes shall not exceed 12 bar.

11.8.2.10 CPVC pipes shall not be used in locations where the temperature is likely to exist or reach more than 65 °C.

11.8.2.11 For seismic zones as defined in IS 1893 (Part 1), acceptance to use CPVC piping in sprinkler installations is with the authority or user having jurisdiction, depending on the seismic zones (as per IS 1893 (Part 1) and their suitability to relevant zones.

11.8.2.12 *Other installation requirements*

a) Where installed exposed, CPVC piping with sprinklers shall be installed below smooth, horizontal and firmly fixed ceilings only. They shall not be installed below false ceilings.
b) Sprinkler system shall be installed with quick response sprinklers of pendent type. Sprinklers shall be installed in such a way that the deflectors are within 200 mm from the ceiling and also the maximum distance between sprinklers shall not exceed 4 m in accordance with the approval restrictions.
c) For horizontal sidewall installations, sidewall sprinklers shall be installed in such a way that the deflectors are within 150 mm from the ceiling and within 100 mm from the sidewall and the maximum distance between sprinklers shall not exceed 4 m in accordance with the approval restrictions.
d) Such installations shall be used with sprinkler heads with temperature rating not exceeding 93 °C.
e) Such installations shall not be used in combustible spaces.
f) Where installed in concealed spaces, the minimum protection for the CPVC pipes and fittings

shall consist of either one layer of 10 mm thick gypsum wall board, 12.5 mm plywood soffits, or a suspended membrane ceiling with lay-in panels or tiles having a weight of 0.07 kg/m^2 when installed with metallic grids. Alternate arrangements for the protection of pipes shall be in accordance with approval conditions.

g) Other restrictions such as jointing of pipes/fittings with solvent cement, thermal expansion of the pipes, supporting arrangements, etc, shall be addressed as specified in the approval conditions and manufacturers installation manual.

h) The minimum riser diameter shall be 25 mm and the maximum riser diameter shall be 50 mm. The maximum distance between the wall(s) and the outside surface of the riser pipe shall be 40 mm.

j) Where obstructions are present below the sprinklers, CPVC piping shall not be used.

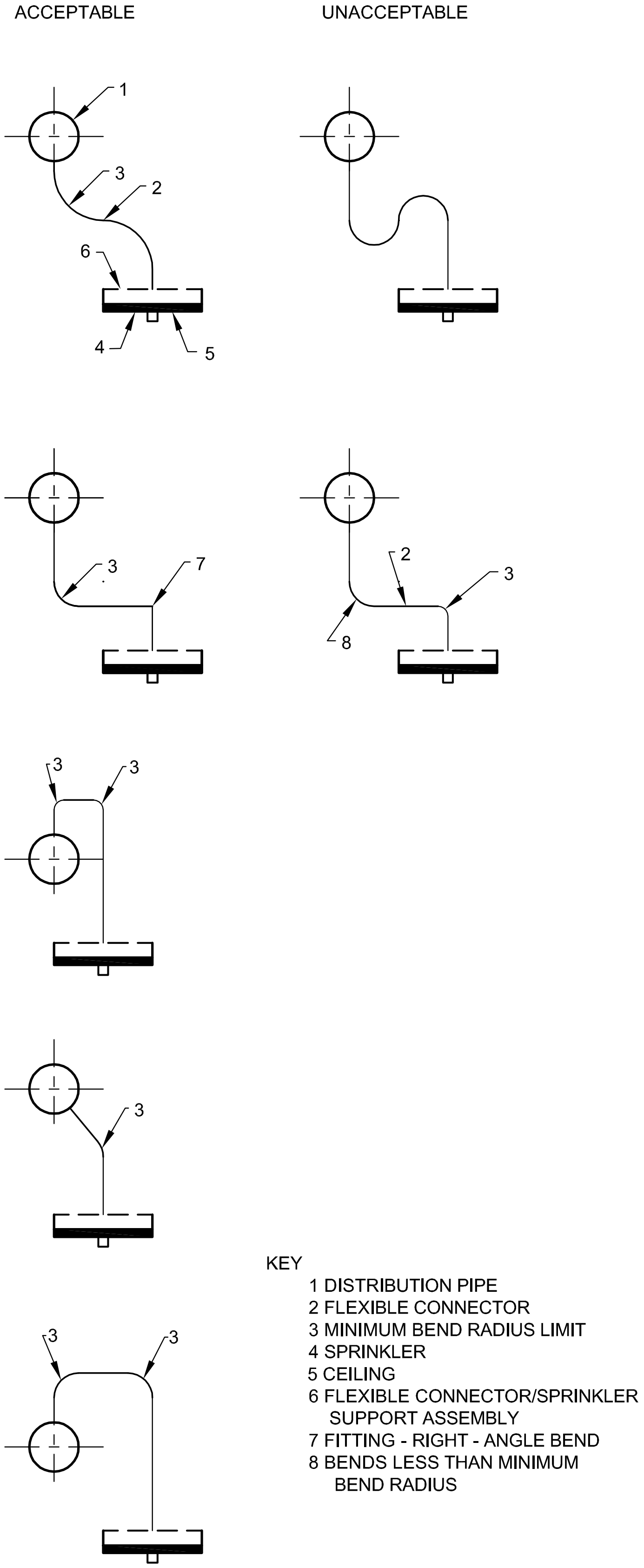
k) It is not allowed to install the system with upright sprinklers.

11.8.3 *Flexible Drop Pipes for Sprinklers (See Fig. 14)*

a) Flexible drop pipes shall be used strictly under situations like those mentioned below and not as an automatic choice or alternative:
   1) If relative movement is likely to occur between different sections of pipe work within the sprinkler system, for example owing to expansion joints.
   2) In highly earthquake prone regions.
   3) For use in commercial suspended ceilings where the space between the ceiling and false ceiling is low, that is, less than 500 mm and constraints exist to install pipes or for perfect alignment of fittings.

b) Flexible drop pipes shall comply with the following material specifications:
   1) Temperature rating: Maximum temperature – 150 °C.
   2) Maximum working pressure – 12 bar.
   3) It shall be capable of withstanding a test pressure of four times the maximum working pressure or 40 bar, whichever is the greater, and shall not include parts which, when subject to fire, might impair either the integrity or the performance of the sprinkler system.
   4) Flexible pipes shall contain a continuous pressure-retaining stainless steel or non-ferrous metal inner tube.
   5) Bend radius shall not be less than 200 mm.
   6) No bends shall be allowed within 250 mm from the terminations of the pipe on either side.
   7) Maximum number of bends allowed for flexible drop pipes shall not exceed 3.
   8) Flexible sprinkler hose length including the connectors at either end is limited to a maximum of 1.20 m to minimize the potential for hose kinking and undesirable movement of a sprinkler after installation.

c) The following requirements shall apply to the installation of flexible drop pipes:
   1) A flexible sprinkler hose drop assembly consists of a flexible hose, inlet fitting for connection to the branch line, and an outlet fitting for connection to the sprinkler. These flexible hose with fittings is intended to be installed using the anchoring devices referenced in the manufacturer's installation instructions. They shall not be supported on the false ceiling framework.
   2) Flexible drop pipes shall not be fitted in the fully extended position.
   3) Flexible pipes and joints shall not be used to take up misalignment between a distribution main and the feed pipes where the concealed space is more than 800 mm.
   4) Flexible drop pipes shall not be embedded in concrete or other building materials.
   5) The flexible drops shall be of make approved/certified by relevant agencies. Approval also includes other fittings like mounting brackets, fitting systems, fitting methods, etc. In addition, manufacturers recommendations shall also be taken into consideration while installation (*see* Fig. 14).
   6) All flexible drop hoses shall have end connections such that they cannot be interconnected to create a longer hose.
   7) Flexible drop connectors shall be used on wet pipe and fully calculated installations only.
   8) Flexible drop connectors shall only be used to connect a single sprinkler to a distribution pipe with a length not exceeding 1.2 m.
   9) Installation of flexible drops shall be as per the approved methods specified in the installation manual and shall not result in kinks, twists, tight bends, crush damage, etc.
   10) Flexible drop pipes shall be used only for pendent type spray sprinklers.
   11) Flexible drop connectors shall only be used in accessible locations where inspections are possible.
   12) Frictional losses in flexible drops shall be taken into account while performing hydraulic calculations.



KEY
1 DISTRIBUTION PIPE
2 FLEXIBLE CONNECTOR
3 MINIMUM BEND RADIUS LIMIT
4 SPRINKLER
5 CEILING
6 FLEXIBLE CONNECTOR/SPRINKLER SUPPORT ASSEMBLY
7 FITTING - RIGHT - ANGLE BEND
8 BENDS LESS THAN MINIMUM BEND RADIUS

FIG. 14 FLEXIBLE DROPS

11.9 Valves

11.9.1 *General*

a) The various types of valves used in the installation are as under:
   1) Stop valves (shut-off valves),
   2) Test valves,
   3) Drain valves,
   4) Flushing valves,
   5) Check valves,
   6) Installation valves,
   7) Pre-action valves, and
   8) Subsidiary valves.

b) All stop valves which may cut off water supply to the sprinkler installation shall:
   1) close in the clockwise direction,
   2) be fitted with an indicator that clearly shows whether it is in the open or closed position; and
   3) be secured in the right position by a strap and padlock or secured in an equivalent manner.

c) Care shall be taken to ensure that all stop, test, drain and flushing valves are suitable for the system pressures, especially in locations, such as high-rise buildings, where high static pressures are likely.

d) Butterfly valves (*see* IS 13095), if used, shall be of the gear-operated type for sizes more than 150 mm and motor operated if more than 300 mm.

e) Valves, which interlock when closed, shall be positioned in a conspicuous place where the key is obtrusive when the valve is closed.

11.9.2 *Main Stop Valves*

a) Where sprinkler systems are fed by a ring main supply pipe arrangement on the premises, stop valves shall be installed to isolate the ring into sections, in such a way that no section shall include more than 4 installation control valve sets (ICVs).

b) One, and only one, main stop valve shall be fitted immediately downstream of the main alarm valve of a standard sprinkler installation.

c) The main stop valve(s) shall be at a fire brigade access level and readily accessible when responding to a fire alarm.

d) Where the working pressure of the installation is more than 7 kg/cm^2, cast iron valves with PN 1.6 rating shall be provided. However, cast steel valves of class 150 shall suffice for installation under all pressure conditions.

11.9.3 *Test Valves*

a) Alarm and pump start test valves — Test valves (15 mm nominal size) shall be provided, as appropriate, to test:
   1) the hydraulic alarm or any electric alarm pressure switch if provided, by drawing water from the downstream side of a wet alarm valve, and any downstream main stop valve(s).
   2) any water flow alarm switch installed downstream of the main installation valve set. The test valve shall be connected downstream of the water flow alarm.
   3) an automatic starting device on a pump.
   4) any pump house sprinkler alarm flow switch installed upstream of the installation control valve.

b) The test valve shall be installed close to the alarm valve, flow switch or pump starter as appropriate.

c) Test valves shall be fitted as follows:
   1) On suction pump supplies, upstream of the pump outlet stop valve and the check valve.
   2) Immediately upstream of the check valve on a water supply feed pipe or trunk subject to any requirements of the inflow water authority, 15 mm test valves shall be fitted, as appropriate, to test the following:
      i) The hydraulic alarm and any electric alarm pressure switch by drawing water from the immediate downstream side of the following:
         A) a wet alarm valve, and any downstream main stop valves; and
         B) an alternate alarm valve.
      ii) The hydraulic alarm and any electric alarm pressure switch by drawing water downstream of the main water supply stop valve and from the upstream side of:
         A) an alternate alarm valve,
         B) a dry pipe alarm valve, and
         C) a pre-action alarm valve.
      iii) Any water flow alarm switch installed downstream of the control valve set by drawing water downstream of the water flow alarm.

d) An automatic pump starting device.

e) Any pump or pressure tank house sprinkler alarm flow switch installed upstream of the control valve set.

f) A test facility shall be provided, incorporating a test valve with any associated fittings and pipework, delivering a flow equivalent to the discharge from a single sprinkler, connected at the hydraulically most remote location on a distribution pipe.

11.9.4 *Drain Valves*

Drain valves shall be fitted as specified in Table 28 to allow drainage from pipework as follows:

a) Immediately downstream of the control valve set or of its downstream stop valve, if fitted;

b) Immediately downstream of any subsidiary alarm valve;

c) Immediately downstream of any subsidiary stop valve;

d) Between a dry pipe or subsidiary control valve set and any subsidiary stop valve installed for testing;

e) Any pipe, with the exception of drop pipes to single sprinklers in a wet installation, which cannot be drained through another drain valve.

f) The valves shall be fitted at the lower end of the pipework and sized as specified in Table 28. The outlet shall be no more than 3 m above the floor and shall be fitted with a suitable plug.

g) In case, drainage cannot be done through the drain valve at the control valve set, extra valves shall be fitted as specified in **11.9.5**.

h) Range pipes shall have a slope towards the distribution pipe of at least 0.4 percent and distribution pipes shall have a slope towards the appropriate drain valve of at least 0.2 percent.

j) Range pipes shall only be connected to the top of distribution pipes to enable drainage of water from range pipes.

k) Every sprinkler riser shall be fitted with a 50 mm drain valve at a readily accessible location to enable operation, testing and maintenance easier. Suitable arrangements shall be provided to collect water discharged through such drain.

Table 28 Minimum Size of Drain Valves

(*Clause* 11.9.4)

Sl No.	Valve Principally Draining	Minimum Diameter of Valve and Pipe mm
(1)	(2)	(3)
i)	Light hazard installation	40
ii)	Ordinary hazard or High hazard processing or High hazard storage installation	50
iii)	Subsidiary installation	50
iv)	A-zone	50
v)	Trapped distribution pipes, diameter ≤ 80 mm	25
vi)	Trapped distribution pipes, diameter > 80 mm	40
vii)	Trapped range pipes	25
viii)	Trapped pipework between dry or subsidiary alarm valve and a subsidiary stop valve installed for testing purposes	15

11.9.5 *Flushing Valves*

a) Where a sprinkler pump draws water from a non-potable source such as a canal, river, lake, etc (with prior permission of the Authorities) flushing valves shall be fitted at the spur ends of the installation distribution pipes.

b) The valves and any associated drain pipework shall be of the same nominal size as the distribution pipe to which they are attached. Each valve outlet shall be fitted with a brass plug cap.

c) It may be desirable in certain cases to fit flushing connections on ranges, for example in the form of a blank tee.

d) In addition to their use for periodic flushing of the pipework, flushing connections may be used to check that water is available and for carrying out pressure and flow tests.

e) Pipework, which is completely full of water, may be damaged by the increase in pressure due to temperature rises. If complete venting of air in an installation is likely to occur, for example in the case of a gridded layout with flushing connections at the extremities, consideration shall be given to the fitting of pressure relief valves.

f) Flushing of all sprinkler systems shall be arranged by providing removable fittings at the end of all cross mains/range pipes. A pipe extension on the end of a cross mains/range pipe that consists of a threaded capped nipple (*see* Fig. 15) shall be available. The diameter of the flushing connection can be minimum 32 mm up to a maximum of 50 mm.

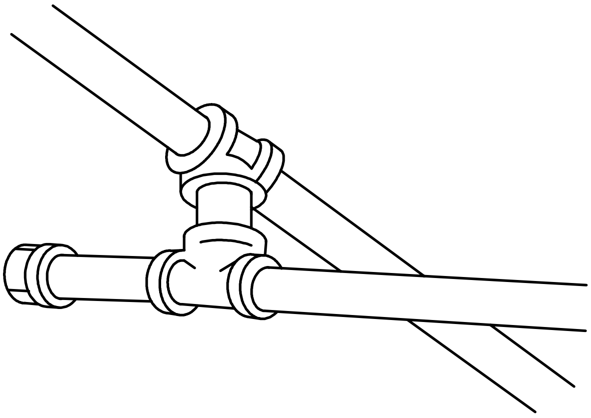


FIG. 15 FLUSHING OF SPRINKLER MAINS

11.9.6 *Check Valves*

a) Check valves shall be provided where more than one water supply is available and the same fitted on each water supply pipe to trunk main.

b) A test cock shall be fitted upstream of the check valve and downstream of the water supply main stop valve, except in the case of a pump supply where it shall be upstream of the pump delivery check valve (*see* IS 4928) and of the outlet stop valve.

11.9.7 *Subsidiary Stop Valves*

Subsidiary stop valves, which shall be of the same nominal size as the pipe in which they are fitted, shall be provided only to control the water supply to the following:

a) Any sprinklers supplied from upstream of an installation main control valve set.

b) Sprinklers under hoods over the dry ends of paper making machines where it is necessary to turn off the sprinklers to enable machine cylinders to be changed. The valve shall be secured open.

c) Sprinklers protecting a computer area. The stop valve shall be electrically monitored or of the type, which interlocks when, closed, and in alternate installations shall be a screw-down diaphragm valve.

11.9.8 *Installation Control Valve (ICV) and Alarm Valve*

a) A sprinkler installation shall be fitted with a suitable main installation valve to control the water supply to the installation. The valve set comprises of:

  1) A main stop valve,

  2) An alarm valve, and

  3) A water motor alarm and gong (*see* Fig. 16).

b) The main installation control valve(s) shall be fitted immediately downstream of the main stop valve.

c) An alarm valve controlling the water supply to either a high temperature area or to an area where freezing temperatures may occur either shall be of a type without a water seal or positioned at such a distance from the protected area that the water seal is not affected by the high temperature or freezing.

d) The installation control valve shall be placed externally in the vicinity of the main entrance of the building protected at an easily accessible place so that the alarm bell sound is heard by the inhabitants/passerby. The valve shall be secured open by a pad locked or rivetted strap and protected against impact damage.

e) If there are genuine constraints in locating the installation control valves outside the buildings, they may be located inside the building in the vicinity of main entrance (subject to approval of authorities concerned). Installation control valve(s) in such cases, shall be located away from any exposure to damage and personnel shall be normally available in the vicinity of the location to get alerted by alarm operation. Also, electrically operated sirens interfaced with the opening of alarm valve, shall be provided outside the building. In no case, installation control valve shall be provided inside basement or inside pump room.

f) A plan of the risk with the position of installation control valves shall be placed in a conspicuous location. A location plate shall be fixed near the valves bearing the following words in raised letters:

SPRINKLER
ALARM VALVE

g) Pressure gauges shall be installed above and below each installation control valve.

h) Pressure relief valve shall be fitted downstream of the installation control valve particularly in tropical regions where ambient temperature is likely to exceed 40 °C.

j) In case of pre-action type installation control valves, adequate facilities shall be available for the dedicated storage of air/inert gas along with necessary hardware required for the safe upkeep of the system. Also, detection system shall comply with various provisions of IS 2189.

k) *Alarm Valve*:

  1) Alarm valves shall be fitted on the main supply pipe immediately above the installation control valve and before any connection is taken off to supply any part of the installation.

  2) In buildings containing more than one installation, each alarm valve must have a number indicated thereon and the relevant alarm gong shall bear the same number in bold letters.

  3) As far as possible, one building shall be protected by one installation control valve only. Where the risk is quite large and has to be fed by more than one valve, the areas fed by the installation control valves shall be planned and suitably demarcated. Details of the division of the sprinkler load with the demarcated areas shall be exhibited near the installation control valves.

  4) The provision of one installation control valve for detached buildings in one compound is not normally permissible. However, if a building requires fewer than 20 sprinklers and the same is situated within 6 m of the adjoining protected building, both the buildings can be protected by the same installation control valve. However, it shall not be permissible to protect more than two buildings with a single installation control valve.

  5) Supervisory facilities shall be provided for the installation control valves in the main control panel in the pump house and where fire alarm system is provided in addition, supervisory facilities shall be available in the alarm control panel.

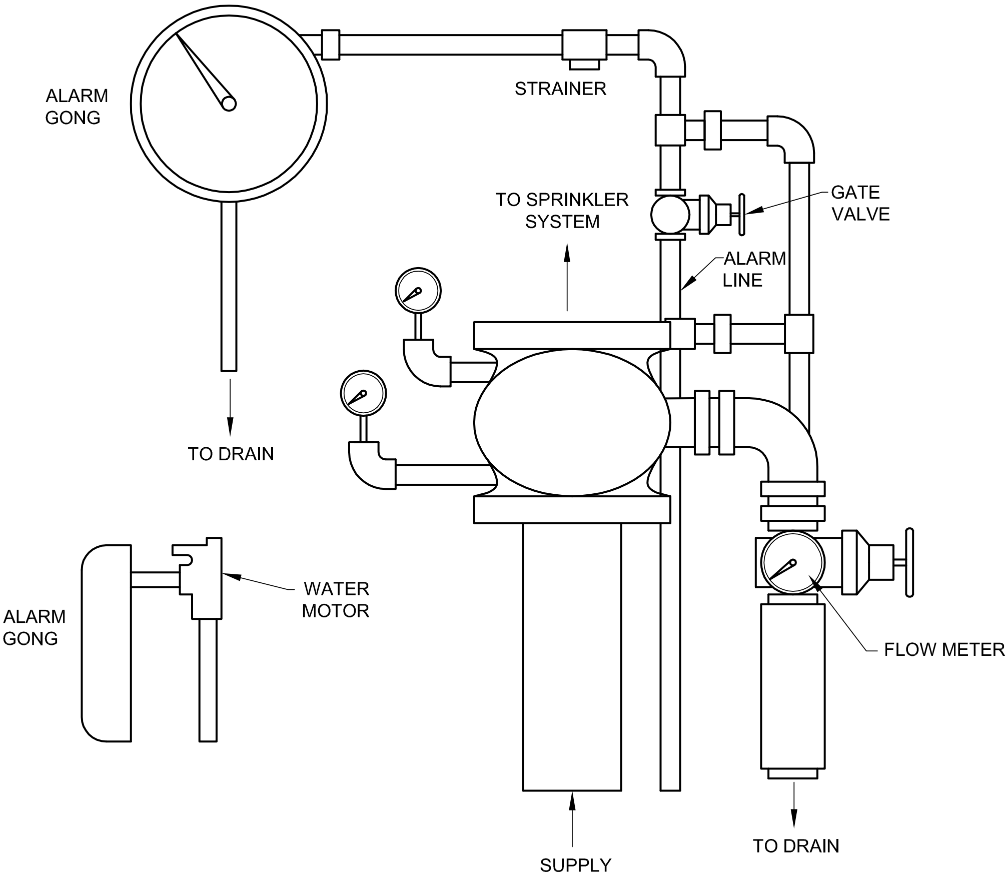


Fig. 16 Installation Control Valve (ICV)

11.9.9 *Multiple Controls*

Multiple controls installed to control open sprinklers or open drenchers or to operate a pressure switch shall be acceptable in specific cases.

11.10 Alarms and Alarm Devices

a) Each installation control valve set shall be provided with a water motor alarm suitable for sprinkler service located as close as possible to the alarm valve.

b) Alarm signal and initiation of alarm shall happen within 45 to 60 s upon release of water from sprinklers in the system or by opening drainage pipe at the control valve sets.

c) Each water motor alarm gong shall be prominently marked with the number of the installation to indicate the building/area protected by the installation alarm valve.

d) The water motor shall be installed with its gong on the outside of an exterior wall and with its centre line not higher than 6 m above the point of connection to the alarm valve. A strainer (*see* IS 907 and IS 3582), readily accessible for cleaning, shall be fitted between the motor nozzle and the alarm valve connection. The water outlet shall be positioned so that any flow of water can be seen.

e) The pipework to the water motor shall be galvanized, medium grade steel complying with IS 1239 (Parts 1 and 2). The equivalent length of pipe between the alarm valve and the water motor shall be not more than 20 m assuming an equivalent length of 3 m for each change of direction. The nominal size shall be not less than 15 mm for equivalent lengths less than or equal to 6 m; and 20 mm for equivalent lengths greater than 6 m. The pipe shall be fitted with a stop valve located within the premises and shall be provided with a permanent drain through an orifice not larger than 3 mm diameter. The orifice place may be integral with the pipe fitting, and shall be of either stainless steel or a non-ferrous material.

f) Any device to reduce the frequency of false or intermittent alarms fitted to the installation shall be suitable for sprinkler service.

11.11 Pressure Gauges

11.11.1 *General and Specification*

Pressure gauges fitted in the installations shall comply with relevant Indian Standards to ensure they are rated for at least twice the expected static pressure at the spot of their installation.

a) Install pressure gauges at the following locations:
   1) On the upstream and downstream sides of any installation control valve, dry-pipe valve, preaction valve, and refrigerated-area valve.
   2) On the upstream and downstream sides of any check valve that is installed on a sprinkler riser in the absence of an alarm check valve, dry-pipe valve, preaction valve, or refrigerated-area valve.
   3) On the upstream side of any sprinkler system's automatic system valve that feeds open sprinklers.
   4) On the air supply that feeds dry-pipe, preaction, and refrigerated-area sprinkler systems.
   5) On the air receiver and air pump supply if they have been provided on dry-pipe sprinkler systems.
   6) At any accelerators on dry-pipe or preaction sprinkler systems arranged to indicate the air pressure at the accelerator.

b) Pressure gauge connection shall be provided near the most remote sprinkler located on either a deluge or exposure protection sprinkler system.

c) The scale subdivision shall not exceed 0.2 bar for a maximum scale value up to and including 10 bar and 0.5 bar for a maximum scale value of more than 10 bar, up to and including 16 bar.

d) The maximum scale value shall be of the order of 150 percent of the maximum pressure.

11.11.2 *Application of Pressure Gauges*

a) *Installation Control Valves* — A pressure gauge shall be fitted at each of the following points:
   1) Main control valve sets.
   2) Immediately downstream of the alarm valve (designated the 'C' gauge).
   3) Immediately upstream of the main control stop valve (designated the 'B' gauge).

b) *Water Supply Connections* — Each pump supply shall be fitted with a damped pressure gauge on the supply pipe immediately downstream of the outlet check valve and upstream of any outlet stop valve.

c) *Removal* — Means shall be provided to enable each pressure gauge to be removed readily without interruption of the water or air supply to the installation.

11.12 Water Flow and Pressure Switches

a) Water flow alarm switches shall only be used in wet installations. A test connection shall be fitted downstream of each switch to simulate the operation of a single sprinkler. It shall be fitted with a drain. The draw-off pipe shall be galvanized steel or copper.

b) The pressure/flow characteristic of the fully opened test valve and draw-off pipe shall be equal to that of the smallest nominal bore sprinkler supplied through the flow switch. Any orifice plate shall be at the pipe outlet and shall be either stainless steel or non-ferrous material.

c) The test pipe outlet shall be positioned relative to the drainage system in such a way that the flow of water can be seen during tests.

11.13 Pressure Regulating Valves (PRVs)

a) Pressure regulating valves shall be used to restrict unwarranted pressure in the installation and piping, particularly in high rise installations.

b) Pressure gauges shall be provided on the inlet and outlet sides of each PRV.

c) A relief valve shall be provided of size not less than 15 mm on the discharge side of the PRVs so as to relieve excess pressure.

d) Means shall be provided downstream of all PRVs for flow tests at sprinkler system demand.

11.14 Sprinkler Rosettes

a) Rosettes shall be made of metal.

b) Rosettes shall not be used to support ceilings or other structures.

c) No part of a rosette shall project from the ceiling below the top of the visible portion of the heat sensitive element of the sprinkler.

d) The escutcheon plates shall be of certified type for use around a sprinkler.

e) Escutcheons used with recessed flush type or concealed sprinklers shall be part of the certified sprinkler assembly.

11.15 Sprinkler Guards

When sprinklers, other than ceiling or flush sprinklers, are installed in a position at risk of accidental mechanical damage, they shall be fitted with a suitable metal guard. Guards used shall be the part of the listed sprinkler assembly.

11.16 Sprinkler Water Shields

a) Sprinklers installed in racks, or under perforated shelves, platforms, floors or similar locations, where water from a higher sprinkler or sprinklers may cause wetting close to the bulb or fusible element, shall be fitted with a metal water shield with a diameter of between 75 mm and 150 mm.

b) Water shields on upright sprinklers shall not be attached directly to the deflector or yoke, and any bracket supports shall be designed so as to minimize obstruction to the sprinkler water distribution. Water shields shall be factory fitted and integral part of sprinklers. The guards shall be listed for use along with the sprinkler installed.

12 PUMPSETS

12.1 General Requirements

a) Pumpsets shall be exclusively used for the sprinkler systems, be of an approved type and shall be of one of the following types, and in all these cases, pumps shall be automatic in action:
   1) Electric motor driven centrifugal pumps,
   2) Compression ignition engine driven centrifugal pumps,
   3) Vertical turbine submersible pumps, and
   4) Multi-stage multi-outlet pumps (high rise applications).

b) Pumps shall be direct-coupled, except in the case of engine-driven vertical turbine pumps wherein gear drives shall be used. Belt-driven pumps shall not be accepted.

c) Parts of pumps like impeller, shaft sleeve, wearing ring, etc shall be of non-corrosive metal preferably of brass or bronze.

d) Where sea water is used or where the quality of the water necessitates the use of special metals and alloys, the use of such metals and alloys shall be insisted upon.

e) The capacity of the pump(s) shall depend on the type of hazard protected and flow requirements as per calculations of water demand for given system. Electrical or diesel-driven pumps supplying sprinkler systems shall be of sufficient capacity to exceed both the system flow rate and pressure demands as determined by hydraulic calculations, by a minimum of 20 percent for both flow and pressure. Pumps shall be chosen with duty parameters as stated in Table 29.

f) In case of electrically driven pumps, it is required to provide a compression ignition engine driven stationary of similar capacity be installed as a standby and *vice-versa.*

NOTE — Notwithstanding the above, if power to motorized fire pumps is obtained from two sources, one of which is a captive generating plant located in a block either 6 m away from all surrounding building or, where this is not feasible, fire separated from adjoining buildings in a manner indicated in **12.2**, more than one pump may be of the electrically-driven type.

Table 29 Duty Parameters of Pumps

[*Clause* 12.1(e)]

Sl No.	**Hazard Type**	**Pumping Capacity** lpm (m^3/h)	**Delivery Pressure** (*see Note* 3) **bar**
(1)	(2)	(3)	(4)
i)	Light	1 620 (96)	5.6
		1 800 (110)	5.6
ii)	Ordinary	2 280 (127)	5.6 / 7.0
		2 850 (171)	7.0
iii)	High and storage	2 850 (171)	7.0
		4 550 (273)	7.0 / 8.8

NOTES

1 It shall be noted that the pumping capacities specified above are applicable only to those occupancies that are not specifically covered in Table 7 of SP 7 (Part 4). This has been highlighted here for greater clarity (*see* Note 2).

2 Fire pumping capacities for all occupancies under groups A to F and a few under groups G and H have been already specified in Table 7 of SP 7 (Part 4) and these shall be adhered to. However, for the remaining occupancies, pumping capacities shall be as per this table.

3 Attention is drawn to Annex B on high rise installations.

g) In case of jockey pumps in such systems to take care of minor leakages, the capacity thereof shall not be less than 3 percent and normally not more than 10 percent of the installed pumping capacity.

h) Each pump shall be provided with a pressure gauge on the delivery side between the pump and the non-return valve [*see* IS 5312 Parts (1 and 2)] and a plate giving the delivery head, capacity and the number of revolutions per minute.

j) Each pump shall be provided with independent suction pipe with flooded suction and further provided with sluice or cut off valves (*see* IS 949 and IS 14846). The net positive suction head (NPSH) available at site exceeds the required NPSH by at least 1 m at 120 percent of the duty point as per the manufacturer's curves.

k) Suction piping shall be laid either horizontal or with a continuous slight rise towards the pump to avoid the possibility of air locks forming in the pipe. No butterfly valves are allowable in suction pipelines.

m) The diameter of the suction pipe shall be such that the rate of flow of water through it is based upon a rate of flow of 120 m per min (*Max*).

12.2 Pump Room Location

12.2.1 *Pump Rooms at Ground Level*

a) Pumps shall not be installed in the open. The pump room shall be so located as to be both easily accessible and where any falling masonry and the like from other buildings occasioned by fire other causes, cannot damage the pump room. It is necessary to install the pump house at ground level and the same shall be so situated as to be directly accessible from the surrounding ground level.

b) Normally, pump rooms shall be located 6 m away from all surrounding buildings and overhead structures.
c) Where this is not feasible, they may be attached to a building provided a fire wall having a rating of at least 120 min is constructed between the pump room and the attached building, the roof of the pump room is of reinforced cement concrete construction at least 100 mm thick and access to the pump room is from the outside.
d) The pump rooms shall normally have brick/concrete walls and non-combustible roof, with adequate lighting, ventilation and drainage arrangements.
e) The pump room shall be located 30 m clear of the equipment/vessels handling or storing flammable liquids/solvents and/or gases.

12.2.2 *Pump Rooms Below Ground Level*

In case of high-rise buildings, fire pump rooms should not be installed within the basement. In such unavoidable situations, the following requirements shall be complied with:

a) Pump house shall be situated so as to be directly accessible from the surrounding ground level.
b) Pump house shall be installed not lower than the first basement. When so installed, direct approach staircase/ramp shall be available from the surrounding ground level, leading directly to the pump house without having to negotiate through other occupancies within the basement.
c) Pump house shall be separated by fire walls all around and doors shall be protected by fire doors (120 min rating).
d) Pump house shall be sufficiently large to accommodate all pumps and their accessories, electrical panels, diesel day tanks, batteries of diesel pumps, etc and also sufficient space shall be available to negotiate around pumps on all sides for easy approach during maintenance. Installation valves and alarm valves, etc shall not be allowed inside the pump room.
e) Exhaust pipes for diesel engines shall be well insulated and taken to a safe location at ground or terrace levels as per the approved engineering practices.
f) Suitable drainage arrangements shall be provided to prevent water stagnation inside pump house.
g) Pump house shall be well ventilated and due care shall be taken to avoid water stagnation.
h) No other utility equipment shall be installed inside fire pump room (other than general water pumps). No utility piping shall pass through the pump house.
j) Butterfly valves shall not be used within the pump house both in suction and delivery headers. They can be used anywhere in the ring mains.
k) Insertions like flexible couplings, bellows, etc in the suction and delivery piping shall be strictly avoided.
m) Neither the pump house nor the water tanks shall be below roads even if the load carrying capacity of the slabs complies with requirements specified in rules.
n) Positive suction shall be provided for the fire pumps.
p) Installation of submersible pumps shall not be allowed. *See* **12.1** (a) (3).

12.3 Requirements for Electrical Pumps

1) The substation(s) and/or diesel generator (DG) house(s) supplying power to the fire pump(s) shall be of incombustible construction and shall be located at least 6 m away from all surrounding buildings. Where this is not feasible, all door and window openings of the surrounding buildings within 6 m of the substation(s) and/or DG house(s) shall be protected by single fire doors and 6 mm thick wired glass in steel framework respectively. Likewise, roof eaves, if any of the surrounding buildings falling within 6 m of the substation(s) and/or DG house(s) shall be cut and wall raised as a parapet. The above provision shall also apply when the substation(s) and/or DG house(s) are within 6 m of each other. *See also* **3.4.6** of SP 7 (Part 4).
2) Where the substation(s) and/or DG house(s) are attached to buildings, a fire wall(s) having a rating of at least 120 min shall be constructed to segregate the substation(s) and/or DG house(s) from the attached buildings and where the attached building is storied, the roof of the substation(s) and/or diesel generator house(s) shall be of RCC construction of at least 100 mm thickness.
3) Transformer cubicles inside these substations shall be separated from HT/LT cubicles and from each other by blank brick/stone/concrete walls of 355 mm thickness or of RCC of 200 mm with door openings, if any, therein being protected by single fireproof doors with fire rating of at least 120 min. The substation(s) and diesel generator house(s) shall also be separated from each other as above.

4) Transformers installed outdoors which are supplying power to fire pump(s), shall also be located at least 6 m away from all the surrounding buildings [(including substation(s) and/or diesel generator house(s)].

   Where this is not feasible, all door and window openings of the surrounding buildings [(including substation(s) and/or diesel generator house(s)] within 6 m of the of the transformers shall be protected by single fire doors and 6 mm thick wired glass in steel framework respectively. Likewise, roof eaves, if any of the surrounding buildings falling within 6 m of the transformers shall be cut and wall raised as a parapet.

5) Blast walls of bricks/stone/concrete blocks of 355 mm thickness or of RCC of 200 mm thickness shall be constructed between two transformers and these walls shall be extended horizontally by 600 mm beyond the extremities of the transformers and vertically 600 mm above the highest point of the transformers.

   NOTE — For high hazard occupancies, substation(s) supplying power to fire pumps shall, in addition to complying with the above provisions, be located 30 m clear of all equipment where flammable fluids having a flash point below 65 °C are handled and/or stored.

6) Overhead feeders to substation(s) supplying power to the fire pump(s) are not permitted within a horizontal distance of:

   a) 15 m of any process building/plant or tanks containing flammable liquids.

   OR

   b) 6 m of any other building or tanks containing non-flammable liquids or of storage in open.

7) In case the feed to such substation(s) is by means of underground cables, the cables shall not pass under any building or permanent structure.

8) Sufficient spare power shall always be available to drive pumping set(s) at all times throughout the year.

9) The electric supply to the pumping set(s) shall be entirely independent of all other equipment in the premises that is, even when the power throughout the entire premises is switched off, the supply to the pump shall continue to be available interrupted.

10) This can be achieved by taking the connection for the pump(s) from the incoming side of the main LT breaker.

11) However, in cases where two or more transformers and/or sources of supply are connected to a common bus bar or where there is provision of a bus coupler between the busbar sections, the connection may be taken through the bus bars (*see* Fig. 17).

12) In case of power being available from two different grids or a captive generation within the complex, all supplies shall terminate at main LT panel and through bus coupler arrangements, power shall be drawn to fire pumps.

13) The fire pump circuit shall be protected at the origin by an automatic circuit breaker so set as to permit the motor to be overloaded during an emergency to the maximum limit permissible by the manufacturers. Further, the under-voltage release/no volt coil of the circuit breaker shall be removed.

    NOTE — Where cable lengths are long enough to warrant back-up protection, authorities may insist on provision for such a protection.

14) It is recommended that telltale lamps which could continuously glow when power is available to the fire pump(s) circuit be provided and fixed in a prominent position, both in the substation and in the pump room.

15) A direct feeder without any tappings, shall be laid from the substation to the pump house. The feeder shall be laid underground and shall not pass under any building or permanent structure.

16) Where there is more than one source of power for the operation of pumping set(s) every electrical circuit shall preferably be so designed as to ensure that when necessary the set(s) continue to operate without the manual operation of an emergency switch.

17) The pumping set(s) shall be securely mounted on a robust bedplate, if of the horizontal type, and shall be free from vibration at all variations of load.

18) The rating and design of motors and switchgear shall conform to the relevant Indian Standards specifications. The motor shall be of continuous rating type and its ratings shall be equivalent to the horse power required to drive the pump at 120 percent of its rated discharge.

19) The motor shall be of totally enclosed type or drip proof type, the latter having their air inlets and outlets protected with meshed wire panels to exclude rodents, reptiles and insects.

20) The motor(s) shall be wound for class B insulation preferably for class E and the windings shall be vacuum impregnated with heat and moisture resisting varnish and preferably glass fibre insulated to withstand tropical conditions.

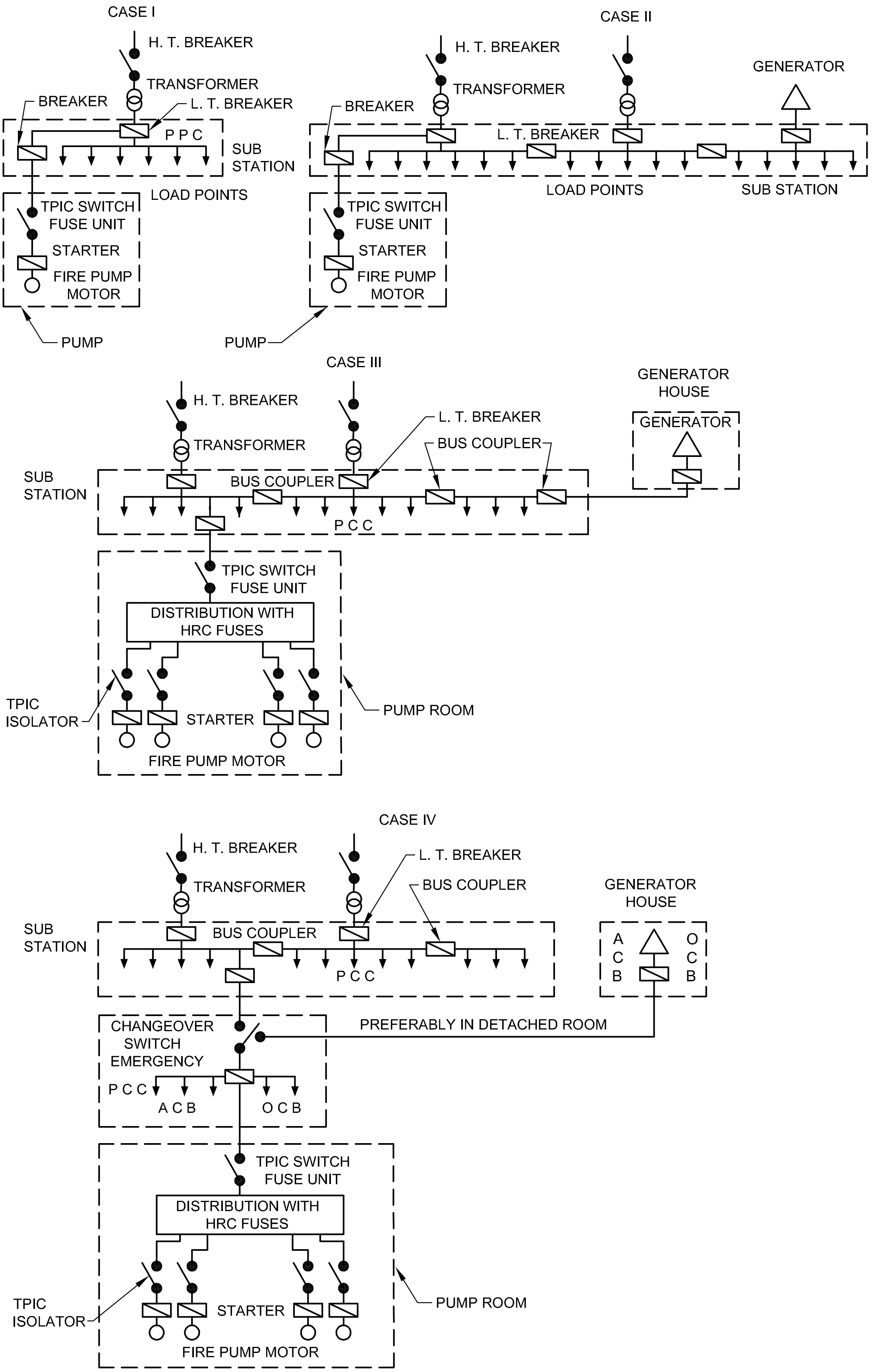


FIG. 17 SINGLE LINE DIAGRAM OF PUMP MOTOR ELECTRIFICATION

21) Motor(s) wound for high tension supplies shall have a suitable fixed warming resistance to maintain the motor windings in a dry condition at all times and particularly under monsoon conditions. The resistance shall be connected to the lighting or other equivalent circuit. Also pump motor and the switchgear inside pump house shall be housed in an enclosure with a degree of protection not less than IP 65.
22) Heating apparatus shall also be provided, when necessary, for medium tension motor where they are located below ground level, in order to maintain the motor windings in a dry condition. Adequate drainage arrangements shall also be provided in the pump house in such cases.
23) The incoming cable to the fire pump room shall terminate in an isolator/breaker which shall feed the fire pump panel.
24) The starting switchgear for the fire pumps should be preferably for direct on line starting but star/delta starters are also acceptable. It shall also incorporate an ammeter with a clear indication of the motor full load current.

    NOTE — Remote controlled starting arrangements are subject to prior approval of the authorities concerned.

25) Cables for motors and switchgears shall be armored or enclosed in heavy gauge screwed steel conduit according to conditions.
26) It is recommended that the equipment throughout be painted fire red (shade no 536 as per IS 5) and suitably marked for identification.
27) Necessary spare parts including a set of fuses (in a glass fronted box) shall be. Kept in readiness at all times in the pump house.

    NOTE — The wiring for the fire pumps in all installations shall be done in accordance with the SP 30.

12.4 Compression Ignition Engine Driven Pumps

a) *Pump Room* — The pump room shall be artificially heated, if necessary, to maintain the temperature of the room above 10 °C. Adequate ventilation shall be provided for the air required for aspiration and to limit the temperature rise in the room to 10 °C above the ambient temperature when the engine is on full load.
b) *Engine* — The engine shall be:
    1) Of the compression ignition mechanical direct injection type, capable of being started without the use of wicks, cartridges, heater plugs or ether, at an engine room temperature of 7 °C and shall accept full load within 15 s from the receipt of the signal to start.
    2) Naturally aspirated, supercharged or turbocharged and either air or water cooled. In the case of charged air cooling by means of a belt driven fan or of a belt driven auxiliary water pump there shall be multiple belts such that should half the belts break, the remaining belts would be capable of driving the fan or pump.
    3) Capable of operating continuously on full load at the site elevation for a period of 6 h.
    4) Provided with an adjustable governor to control the engine speed within 10 percent of its rated speed under any conditions of load up to the full load rating. The governor shall be set to maintain the rated pump speed at maximum pump load.
    5) Provided with an in-built tachometer to indicate the rpm of the engine.
    6) Provided with a time totalizer (hour counter).
    7) Any manual device fitted to the engine which could prevent the engine starting shall return automatically to the normal position.
c) Engines, after correction for altitude and ambient temperature shall have bare engine horsepower rating equivalent to the higher of the following two values:
    1) 20 percent in excess of the maximum brake horsepower required to drive the pump at its duty point.
    2) The brake horsepower required to drive the pump at 120 percent of its rated discharge.
d) The coupling between the engine and the pump shall allow each unit to be removed without disturbing the other.
e) *Cooling System* — The following systems are acceptable:
    1) Cooling by water from the discharge of fire pump (taken off prior to the pump discharge valve) direct into the engine cylinder jackets *via* a pressure reducing device to limit the applied pressure to a safe value as specified by the engine manufacturer. The outlet connection from this system shall terminate at least 150 mm above the engine water outlet pipe and be directed into an open tundish so that the discharge water is visible.
    2) A heat exchanger, the raw water being supplied from the fire pump discharge (taken off prior to the pump discharge valve) via a pressure reducing device, if necessary, to limit the applied pressure to a safe value as specified by the engine manufacturer. The raw water outlet connection shall be so designed that

the discharged water can be readily observed. The water in the closed circuits shall not be less than that recommended by the engine manufacturer. If the auxiliary pump is belt driven there shall be multiple belts so that should half the belts break, the remaining belts shall be capable of driving the pump.

3) A frame or engine mounted air-cooled radiator with a multiple belts driven fan from the engine. When half the belts are broken the remaining belts shall be capable of driving the fan. The water in the closed circuit shall be circulated by means of the auxiliary pump driven by the engine and the capacity of the closed circuit shall be not less than that recommended by the engine manufacturer.

4) Direct air cooling of the engine by means of multiple belts driven fan. When half the belts are broken the remaining belts shall be capable of driving the fan.

NOTE — In case of systems described above, a failure actuated audio-visual alarm shall be incorporated.

f) *Air Filtration* — The air intake shall be fitted with the filter of adequate size to prevent foreign matter entering the engine.

g) *Exhaust System* —The exhaust shall be fitted with a suitable silencer and the total backpressure shall not exceed the engine maker's recommendation. When the exhaust system rises above the engine, means shall be provided to prevent any condensate flowing into the engine.

h) *Engine Shutdown Mechanism* — This shall be manually operated and return automatically to the starting position after use.

j) *Fuel System*

1) Fuel — The engine fuel oil shall be of quality and grade specified by engine makers. There shall be kept on hand at all times sufficient fuel to run the engine on full load for 180 min, in addition to that in the fuel tank.

2) *Fuel tank* — The fuel tank shall be of welded steel construction relevant to Indian or foreign standard for mild steel drums (IS 2552). The tank shall be mounted above the engine fuel pump; to provide a gravity feed unless otherwise recommended by the manufacturers. The tank shall be fitted with an indicator showing the level of fuel in the tank. The capacity of the tank shall be sufficient to allow the engine to run on full load for:

i) Light hazard : 60 min
ii) Ordinary hazard : 120 min
iii) High hazard : 180 min

NOTE — Where there is more than one compression ignition engine driven pump set there shall be separate fuel tank and fuel feed pipe for each engine.

3) *Fuel feed pipes* — Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. Pipe joints shall not be soldered and plastic tubing shall not be used.

k) *Auxiliary Equipment*

The following shall be provided:

1) sludge and sediment trap,
2) a fuel level gauge,
3) an inspection and cleaning hole,
4) a filter between the fuel tank and fuel pump mounted in an accessible position for cleaning,
5) means to enable the entire fuel system to be bled of air. Air relief cocks are not allowed; and
6) Screwed Plugs are permitted.

m) *Starting Mechanism*

Provision shall be made for two separate methods of engine starting, namely:

1) Automatic starting by means of a battery powered electric starter motor incorporating the axial displacement type of pinion, having automatic repeat start facilities initiated by a fall in pressure in the water supply pipe to the spray installation. The battery capacity shall be adequate for ten consecutive starts without recharging with a cold engine under full compression.

2) Manual starting by crank handle, if engine size permits through electric starter motor.

NOTE — The starter motor used for automatic starting may also be used for manual starting provided there are separate batteries for manual starting.

n) *Battery Charging* — The means of charging the batteries shall be by a 2-rate trickle charger with manual selection of boost charge and the batteries shall be charged in position. Where separate batteries are provided for automatic and manual starting the charging equipment shall be capable of trickle charging both the batteries simultaneously. Equipment shall be provided to enable the state of charge of the batteries to be determined.

p) *Tools* — A standard kit of tools shall be provided with the engine and kept on hand at all times.

q) *Spare Parts* — The following spare parts shall be supplied with the engine and kept on hand:

   1) Two sets of fuel filters, elements and seals.
   2) Two sets of lubricating oil filters, elements and seals.
   3) Two sets of belts (wherever used).
   4) One complete set of engine joints, gaskets and hoses.
   5) Two injector nozzles.
   6) One complete set of piston rings for each cylinder.
   7) One inlet valve and one exhaust valve.

r) *Engine Exercising* — The test shall be for a period of at least 5 min each day. Where closed circuits cooling systems are used the water level in the primary system shall be checked at the time of carrying out each test and, if necessary, water shall be added during the course of test procedure.

s) A written declaration shall be given that the following conditions will strictly complied with:
   1) to test the engine at least once a week,
   2) to maintain the temperature of the engine room at not less than 4.5 °C at all times,
   3) to maintain the minimum, quantity of fuel oil required as desired in these clauses,
   4) to use a good grade of fuel oil equivalent in quality to that specified by the engine maker, and
   5) to keep on hand the spare parts required as specified above.

12.5 Other Requirements for Pumps

a) Where there is more than one pump set installed, the suction pipes shall be interconnected through a common header.

b) Where a redundant system is required, the full flow demand of the system shall be met by a main pump set and a reserve pump set having the same capacity.

c) Two pressure sensing devices shall be provided to start each pump set. They shall be connected in series such that opening the contacts of either switch will start the pump set with normally closed contacts.

d) Means shall be provided for testing pump set starting with each pressure sensing device.

e) If any isolating valve is installed on the connection between the trunk main and any pump set starting pressure sensing device, a non-return valve shall be installed in parallel with the isolating valve so that a fall in pressure on the trunk main will be transmitted to the pressure switch even when the isolating valve is closed.

f) The first pump set shall start automatically when the pressure in the system falls to a pre-set value that shall be indicated and exhibited inside pump room.

g) Where two pump sets are installed, there shall be a pressure gradient setting after which the second ones shall also start automatically, and a delay shall be provided so to avoid simultaneous starting of both units.

h) Once the pumpset has started, it shall continue to run until stopped manually.

j) The following conditions shall be monitored for electric pump:
   1) power available to the motor and, where a.c., on all three phases;
   2) pump on demand;
   3) pump running; and
   4) start failure.

k) All monitored conditions shall be visually indicated individually in the pump room. They shall also be visually indicated at a location permanently attended by responsible personnel. Pump running and fault alarms shall also be audibly indicated at the same place.

m) *Starter Alarm Indication (Engine Driven Pump Set)* — The following conditions shall each be indicated both locally and at a responsibly manned location:
   1) the use of any switch which prevents the engine starting automatically;
   2) the failure of the engine to start after the six attempts;
   3) pump running; and
   4) diesel controller.

n) When commissioning an installation, the automatic starting system of the diesel engine shall be activated with the fuel supply isolated for the six cycles each of no less than 15 s cranking and no more than 15 s or less than 10 s rest. After completion of the starting cycles the fail to start alarm shall operate. The fuel supply shall than be restored and the engine shall start when the manual start test button is turned on.

13 WATER SUPPLY ARRANGEMENTS FOR SPRINKLER SYSTEM

13.1 Water Supply

a) It shall be noted that the water capacities specified in Table 30 below are applicable only to those occupancies that are not specifically provided in Table 7 of SP 7 (Part 4). This has been highlighted here for greater clarity [*see* (b)].

b) Fire water capacities for all occupancies under groups A to F and a few under groups G and H have been already specified in Table 7 of SP 7 (Part 4) and these shall be adhered to. However, for all the remaining occupancies, water capacities shall be as per Table 30.

c) When more than one water-based fire protection system complying with respective Indian standards are available, water capacity shall be provided, considering the aggregate requirements for all such systems.

d) Water for the sprinkler system shall be stored in any easily accessible surface or underground reservoir or above ground tanks of steel, concrete or masonry. The effective capacity of the reservoir (above the level of suction puddle flange or the level of top of the pump casing whichever is higher by a height equivalent to three times the diameter of the suction pipe in case of positive suction) for various classes of occupancies of sprinkler installations shall be as indicated in Table 30.

e) If sprinkler protection is also backed up an up-to-date hydrant system as per IS 13039, water requirement for sprinkler system shall comply with Table 30.

Table 30 Sprinkler Water for Various Hazard

(*Clause* 13.1)

Sl No.	Hazard Type	Exclusive Water Storage
(1)	(2)	(3)
i)	Light	Not less than 30 min run for the pumping capacity or 60 m^3 whichever is greater
ii)	Ordinary	Not less than 60 min run for the aggregate pumping capacity or 150 m^3 whichever is greater
iii)	High and storage	Not less than 120 min run for the aggregate pumping capacity

f) If sprinkler protection is not backed up by an up-to-date hydrant system, water requirement for sprinkler system shall need to be loaded for supplementing the protection with hose reels (*see* IS 884) and tentative hydrants as detailed below:

1) Light hazard : 15 m^3
2) Ordinary hazard : 30 m^3
3) High hazard : 60 m^3

13.2 Multiple Hazard Installation

For designing systems for multiple hazard classifications, water supply requirements and duration of water supply shall comply with following:

a) Water supply shall be worked out for each individual hazard within the system and highest requirement shall be considered.

b) Water supply shall be adequate to supply for the highest hazard classification within the system.

c) If classification of a higher hazard lies only within an area of 40 m^2, design of the system and water requirements shall follow most dominating occupancy.

NOTE — For storage hazards, as well as specific hazards, water capacity and supplementary requirements shall vary according to the type of protection as detailed in the subsequent clauses in this section.

13.3 Other Requirements

a) A higher capacity of reservoir than that required as per Table 30 may be stipulated by the Authorities where considered necessary.

b) Water supplies for the sprinkler installations shall be free from suspended, fibrous or other matters, which may accumulate in the system pipework, and it is recommended to use filtered water for the system.

c) The use of salt or brackish water is not normally allowed. In special circumstances where there is no suitable fresh water source available, consideration may be given for the use of salt or brackish water provided the installation is normally charged with fresh water.

d) Combined reservoirs for other firefighting systems such as hydrant system, water spray systems, etc along with the sprinkler system are permissible provided; all the suction inlets are at same level; and aggregate capacity of the reservoir is equal to the total requirement of all the systems put together.

e) Reservoirs of and over 225 m^3 capacities shall be in two independent but interconnected compartments with a common sump to facilitate cleaning and repairs. The construction and arrangement of the reservoir and the common sump shall be in accordance with the provisions in IS 13039.

f) Level indicator shall be provided for measuring the quantity of water stored at any time. The indicator shall preferably be graduated to read directly in m^3 of water.

g) Water reservoir shall be cleaned at least once in 2 years or more frequently if necessary to prevent contamination and sedimentation.

h) It is advisable to provide adequate inflow into the reservoir so that the protection can be re-established within a short period.

14 PRE-COMMISSIONING AND ACCEPTANCE TESTS

14.1 An acceptance test must be conducted by the installing contractor on every new sprinkler system prior to placing it into service. The acceptance test will consist of, but not be limited to, the following items:

a) Ensure all working drawings and specifications for the sprinkler system have been acceptable.

b) Ensure the sprinkler system has been installed per the reviewed and accepted working drawings.

c) Ensure any deviations from the working drawings have been listed and are considered acceptable by authorities.

14.2 Installation of Pipework

a) All installation pipework shall be pressure tested in accordance with **11.1.8**; and the installation piping (from the pump house up to the installation valve and also the installation piping with sprinklers) shall be capable of withstanding for 120 min a pressure equivalent to 150 percent of the maximum working pressure.

NOTE — In water sensitive areas, it is advisable to test the pipes pneumatically before carrying out any hydraulic testing.

b) The coating and wrapping of the underground wrought or mild steel pipes shall be carried out and also subjected to 'Holiday' tests as per IS 10221.

c) In addition to hydraulic testing as stated above, an air pressure leakage test at 3 bar shall be carried out for 24 h on the piping downstream of alarm valve in case on pre-action systems.

14.3 Initial Testing to Regular Testing Procedures

The system shall be tested as specified in **15.3, 15.4** and **15.5** that is, making the initial tests which shall become routine tests later as a part of upkeep of the system.

14.4 Water Supplies

a) The entire piping system shall be thoroughly flushed before commissioning in order to remove foreign materials which might have entered or be present in the system piping during the course of installation or which may have been present in existing piping at maximum flow rate available to the system consideration shall be given to the disposal of water discharged during the flushing.

b) In case of large installations [where the number of sprinklers in a single building and those in the buildings communicating therewith exceed 500], it is necessary to ascertain the hydraulic balance to check the performance of the pump when working at most favourable and unfavourable locations. Pressure at the outlets of the orifice plates shall be measured at all locations to check the correctness of the size of orifice plates selected.

c) Each installation valve shall be tested separately. The pump shall start automatically and the supply pressure at the appropriate flow rate shall not be less than the appropriate value specified in **12.3** and **12.4** for all types of hazards.

d) It shall be verified *via* physical testing that all sprinkler system control valves are in the fully open position. Also it shall be ensured any tamper alarms provided for the sprinkler system control valves function properly during the physical testing of the control valves.

e) The drain valves fitted above the installation valve shall be opened and the time taken for the alarm gong to operate be noted. There shall not be a significant variation in the timing between the 15 mm and 50 mm drain valves fitted above the installation valve to drain the water from the installation.

14.5 Flow Test

a) Upon the satisfactory completion of the entire installation, flushing and hydrostatic testing of sprinkler system, performance flow test of sprinkler system shall be conducted by any one or more of the following methods as required by the user or the concerned authorities:

    1) By shattering the sprinkler bulbs in a convenient floor/area; and

    2) By operating test line installed in the fire pump room and with the help of flow meter and pressure gauge.

b) Flow test results shall be satisfactory and results shall be recorded and approved by user or authorities concerned.

c) Supervisory alarm of isolation/control valves shall be tested by closing and opening of the valves and water flow monitoring alarms shall be tested opening test and drain valves. The interface signals at fire alarm control panel shall be verified and recorded.

d) It shall be proved through a full-flow test that the available water supply is as indicated on the submitted and accepted working drawings.

14.6 Pump Output

A running pressure test shall be carried out at the delivery of the pump at full load conditions (Q_{max}). The pressure obtained in the test can be used to correct the pressure available at the 'C' gauge of the installation valve.

14.7 Auto Start of Diesel Pumps

When commissioning the installation, the automatic starting system of the diesel engine driven pump set shall be activated with the fuel supply isolated for 6 cycles each of not less than 15 s cranking and at not more than 15 s rest. After completion of six starting cycles 'the fail to start alarm' shall operate. The fuel supply shall then be restored and the pump set shall start when the manual start button is operated.

14.8 Installation of Valves

a) All the valves shall be physically checked for proper installation and leakage if any. The reading of the pressure gauges shall be checked to see whether they match after a few drain tests.

b) The proper functions of the alarm gong associated with the installation valve and its level of audibility shall be checked. An audibility level of 85 db above the background noise level is required.

14.9 Alarm Panel

a) Ensure any alarms provided for the sprinkler system are received at the alarm control panel, as well as at the alarm monitoring station, if one is provided. If local alarms are provided, ensure they function properly.

b) Verify proper function of all actuation systems, associated detection devices, and any interlocked equipment required for adequate sprinkler system operation.

15 UPKEEP OF THE SPRINKLER INSTALLATION

15.1 General Arrangements

a) The user shall carry out a programme of inspection and checks, arrange a test, service and maintenance schedule and keep appropriate records including a logbook, which shall be produced on demand.

b) The user shall arrange for the test, service and maintenance schedule to be carried out under contract by the system installer or a similarly qualified company.

c) After an inspection, check, test, service or maintenance procedure the system, automatic pumps and all other associated hardware shall be returned to the original operational condition.

15.2 Precautions and Procedures When System is not Operational

a) Maintenance, alterations and repair of systems not fully operational shall be carried out in a way that will minimize the time and extent of non-operability.

b) When an installation is rendered inoperative, the user should implement compensatory measures. These measures include: shutting of fire doors and shutters, alertness of the security and safety staff, reinforcement of first aid appliances, keeping other firefighting systems operational, etc.

c) As much as possible of the installation shall be retained in an operative condition by blanking off pipework feeding the inoperative part or parts where work is taking place.

d) In case of manufacturing units, where the repairs and alterations are extensive, or it is necessary to disconnect a pipe exceeding 40 mm nominal diameter, or to overhaul or to remove a main stop valve, alarm valve or check valve, every effort shall be made to carry out the work when the machinery is stopped.

e) Any pump out of commission shall be isolated by means of the valves provided.

15.3 Planned Shut Down

a) Authorities like the insurance companies, local fire service, etc shall be kept informed before shutting of the installation for any reason whatsoever.

b) A round through the unit shall be undertaken before a part or total shut down to ensure that there is no indication of fire.

c) The heads of all the departments or blocks shall be notified in writing that the installation shall remain inoperative and they should exercise abundant caution during the period.

d) Particular attention should be given to situations where installation pipework passes through walls or ceilings where these may feed sprinklers in areas needing special consideration.

15.4 Unplanned Shut Down

When the installation is rendered inoperative as a matter of urgency or by accident, the measures stated above for planned shutdown shall be implemented with least possible delay.

15.5 Action following sprinkler operation

a) Following the operation of sprinkler(s), the operated heads shall be removed and replaced with appropriate sprinkler heads and water supply shall be restored.

b) The sprinklers in the vicinity of the operated sprinklers shall be checked for damage by heat or any other cause and replaced if necessary.

c) The sprinkler pump shall not be shut off until the extinguishment of the fire. The starting of the pump shall be automatic and the stopping of the pump after an extinguishment shall be manual.

15.6 Periodical Testing and Maintenance

15.6.1 *General*

a) Sprinkler systems require competent and effective care and maintenance to assure that they will perform their purpose effectively at the time of fire. Systems shall be serviced and tested periodically by personnel trained in this work. An inspection contract with a qualified agency for service, test, and operation at regular intervals is recommended. *See also* IS 15301.

b) Operating and maintenance instructions and layout shall be available or can be posted at control room and/or at the fire station of the plant. Selected plant personnel shall be trained and assigned the task of operating and maintaining the equipment.

c) At weekly, or other frequent, regular scheduled plant inspection, equipment shall be checked visually for obvious defects such as broken or missing parts, external loading or other evidence of impaired protection.

d) At least once a week the system shall be visually checked and the reading of various pressure gauges of each installation valve shall be recorded.

e) A trained pump man shall be available on all shifts and at all hours to operate the pump or whenever required.

15.6.2 *Fire Water Reservoirs/Tank*

a) It shall be ensured that firewater tank reservoirs are always full and free from any foreign materials. The water level shall be recorded weekly.

b) Depending upon quality of water, reservoirs shall be cleaned once in a year or two years and sludge formation shall be prevented.

15.6.3 *Fire Pumps*

a) All the fire pumps shall be run at least 5 min everyday. During testing water level of priming tank, delivery pressures of pumps, speed, and also other parameters are to be checked and recorded.

b) All pump glands shall be maintained in good working conditions and checked weekly.

c) The bearing grease caps shall be checked once every week and refilled with fresh grease, if necessary.

d) Starter contacts shall be cleaned every week.

e) Insulation resistance of pump motors shall be examined once in every 6 months and record shall be maintained.

f) Starting mechanism of diesel engine must be checked, the battery charger and also the batteries must be maintained in effective conditions and the engine shall be run at least for 5 min every day.

15.6.4 *Sprinkler System Installation*

a) All piping shall be examined at intervals to determine its conditions. Frequency of inspections will be dependent upon local conditions and shall be examined once in a year.

b) All the installation valves and sprinkler installation and associated equipment shall be serviced and tested annually by qualified personnel.

c) Discharge test of sprinklers shall be carried out at least once in 6 months. After each operation, sprinklers shall be removed and cleaned, unless observations under flow conditions indicate this is not necessary.

d) Manual checking devices shall be operated at least twice annually.

e) When normally opened valves are closed following the system operation or test, suitable procedures shall be instituted to ensure that they are reopened and that the system is promptly restored to full normal operating condition.

f) All sprinklers shall be inspected for proper positioning or test, external loading and corrosion and cleaned if necessary, based on experience but at least once in 6 months.

g) The entire system shall be flushed at least once a year.

h) It is important to ensure that the sprinkler bulbs are kept free from paint or dust (otherwise it may not function correctly) and that the bulbs are accessible and clearly identified for maintenance purposes.

j) All the equipment pertaining to the sprinkler system shall be painted at least once in 2 years.

k) Installation valve and alarm gong assembly.

m) The pressure gauge readings above and below the valves shall be monitored everyday at commencement of the first shift.

n) The time taken for the operation of alarm gong after opening the drain valves shall be monitored every week and corrective actions taken in case of malfunction of alarm gong.

p) The alarm gong assembly shall be checked thoroughly once in 3 months.

15.6.5 Readymade maintenance chart and summary sheets for the hydraulic calculation are shown in Table 31.

Table 31 Periodical Testing and Maintenance Chart

(*Clause* 15.6.5)

Sl No. (1)	Subject (2)	Activities (3)	Duration (4)
i)	Reservoir	Level checking	Weekly once
		Cleaning	In two years
ii)	Pump	Running test	Daily 5 min
		Test flow	Annually
		Lubrication	Quarterly
		Gland packing	Weekly
		Overhaul	Once in two years
iii)	Suction pipes	Checking/cleaning	Once in six months
iv)	Strainers	Checking/cleaning	Once in six months
v)	Engine	Running	5 mins everyday
		Lubrication	Quarterly
		Battery	Status weekly
		Load test	Annually
		Overhaul	Once in 2 years
		Fuel tank check	Daily

Table 31 (*Concluded*)

Sl No.	Subject	Activities	Duration
(1)	(2)	(3)	(4)
vi)	Motor	Lubrication	Weekly
		Starter contact checking	Weekly
		Insulation resistance	Half yearly
vii)	Main piping	Flushing	Once in 2 years
		Gauge pressure	Check daily
viii)	Sluice valves (*see* IS 909)	Operation	Monthly
		Gland packing	Monthly
		Lubrication	Quarterly
ix)	Installation valves	Operation	Weekly
		Alarm check	Weekly
		Overhaul	Annually
		Cleaning	Quarterly
x)	Sprinkler piping network	Total draining, flushing and re-charging with water	Once in six months
xi)	Sprinklers	Cleaning Flow test	Quarterly Quarterly
xii)	Detector element	Performance	Six monthly
xiii)	Sprinkler installation	Performance	Quarterly
		Physical check up of piping for seeing dislocation of support, wrong orientation over loading, etc.	Monthly
xiv)	Flow switches	Check for correct function	Monthly
xv)	Pressure gauges	Calibration Check readings	Annually Weekly
xvi)	Painting of installation	–	Every two years

15.7 Hydraulic Calculations – General

a) *Summary sheet*

The summary sheet should contain the following information:

1) Date,
2) Location,
3) Name of owner and occupant,
4) Building or plant unit number,
5) Description of hazard,
6) Name and address of contractor,
7) Design purpose (type of system),
8) Minimum rate of water application,
9) Total water requirement as calculated including hydrant system where applicable,
10) Water supply information in detail, and
11) Building-wise details showing the total discharge and pressure at the top of installation valve.

b) *Detailed working sheet*

Detailed working sheet or computer print-out sheets should contain the following information:

1) Identification of calculation covered,
2) Description and discharge constant (K) for the type of sprinkler used.
3) Hydraulic design reference points.
4) Flow, in lpm.
5) Pipe size (mm).
6) Pipe lengths in metre and details of fittings,
7) Equivalent pipe lengths for fittings and devices, in m,
8) Friction loss, in bar/m,
9) Total friction loss between reference points, in bar,
10) Elevation head in bars between reference points,
11) Required pressure in bars at each reference point,
12) Design details of orifice plates,
13) Velocity pressure and normal pressure if included in calculations, and
14) Notes to indicate starting points with reference to other sheets or to clarify data shown.

Where extending existing system hydraulic calculations are to be furnished indicating the previous design, flow and pressure at points of connection and adequate additional calculations to indicate the effect on existing system.

15.8 Yearly inspection round through the protected buildings to check the following important observations:

a) Have any structural modifications, alterations in layout, extensions to existing structure, partitions and cabins, new false ceilings, etc been made since the last inspection round which necessitate changes to the sprinkler system.
b) Are there any new buildings, mezzanines or extensions?
c) Has there been a change in occupancy to all or any part of the protected building?
d) Is the ambient temperature range still within acceptable limits for the design of the sprinkler system?
e) Has any painting or decoration been undertaken since the last inspection?

f) Have there been any significant changes to plant or equipment (quantity and location), or changes in production?
g) Is the storage type still consistent with the sprinkler system design (that is free-standing storage has not changed to rack storage and *vice-versa*)?
h) Is the design of the rack sprinklers consistent with the storage category?
j) Are flues (horizontal and vertical) within the storage racks kept clear as designated by the design requirements?
k) Are minimum clearances maintained between stored items and sprinkler heads?
m) Has the nature of goods stored or their packaging changed? Does this alter the category of stored goods?
n) Have there been any changes to storage arrangements (plastic pallets, shelving, drum dollies, boxes or totes)?
p) Have there been any changes in storage height?
q) Where a smoke or heat detector system interacts with a sprinkler system, is a suitable maintenance contract in force?
r) Have there been any problems with the sprinkler system?
s) Any changes to the air handling systems and any new ducts added (having a width of more than 1 m)?
t) Any obstructions to the sprinklers due to change in layout?
u) Any changes within the concealed space like adding utility piping, ducts, etc which may obstruct the sprinkler layout?
v) Was there any seismic activity since last inspection? In such case, better to have a closer look at the non-metallic and flexible sprinkler piping for damages or misalignment, if any.

Based on the observations, remedial measures shall be undertaken to keep the installation as per the provisions of this standard.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
5 : 2007	Colours of ready mixed paints and enamel (*sixth revision*)
884 : 1985	Specification for first-aid hose reel for fire fighting (*first revision*)
907 : 1984	Specification for suction strainers, cylindrical type for fire fighting purpose (*second revision*)
908 : 1975	Specification for fire hydrant, stand post type (*second revision*)
909 : 1992	Specification for underground fire hydrant: Sluice valve (*third revision*)
949 : 2012	Emergency (rescue) tender — functional requirements (*third revision*)
962 : 1989	Code of practice for architectural building and drawings (*second revision*)
1239 (Part 1 : 2004)	Steel tubes, tubulars and other wrought steel fittings — Specification Steel tubes (*sixth revision*)
(Part 2 : 2011)	Steel sockets tubular and other steel pipe fittings (*fifth revision*)
1536 : 2001	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage (*fourth revision*)
1537 : 1976	Vertically cast iron pressure pipes for water, gas and sewage (*first revision*)
1538 : 1993	Cast iron fittings for pressure pipes for water, gas and sewage (*third revision*)
1879 : 2010	Malleable cast iron pipe fittings — Specification (*third revision*)
1893 (Part 1) : 2016	Criteria for earthquake resistant design of structures: Part 1 General provisions and buildings (*sixth revision*)
2189 : 2008	Specification for heat sensitive fire detectors for use in automatic fire alarm system (*fourth revision*)
2552 : 1989	Steel drums (galvanized and ungalvanized) (*third revision*)
3582 : 1984	Specification for basket strainers for firefighting purposes cylindrical type) (*first revision*)
3589 : 2001	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 to 2540 mm outside diameter) (*third revision*)
3614 : 2021	Fire check doors: Plate metal covered and rolling type (*first revision*)
3624 : 1987	Pressure and vacuum gauges (*second revision*)
4928 : 1986	Specification for delivery valve for centrifugal fire pump outlet (*first revision*)
5312 (Part 1) : 2004	Swing check type reflux (non-return] valves for water works purposes: Part 1 Single-door pattern (*second revision*)
(Part 2) : 2013	Part 2 Multi-door pattern (*first revision*)
7181 : 1986	Horizontally cast iron double flanged pipes for water, gas and sewage (*first revision*)
7673 : 2004	Glossary of terms for fire fighting equipments (*first revision*)
8329 : 2000	Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage — Specification (*third revision*)
8757 : 2021	Glossary of terms associated with fire safety (*second revision*)
9972 : 2021	Specification for automatic sprinkler heads for fire protection (*second revision*) (*under publication*)
10221 : 2008	Code of practice for coating and wrapping of underground mild steel pipelines (*first revision*)

IS No.	*Title*
12456 : 2004	Code of practice for fire protection of electronic data processing installation (*first revision*)
13039 : 2014	Code of practice for provision and maintenance of external hydrant system (*first revision*)
13095 : 1991	Butterfly valves for general purposes
14846 : 2000	Sluice valve for water works purposes (50 to 1200 mm size)
15301 : 2003	Code of practice for installation, operation and maintenance of stationary fire protection pump
15325 : 2020	Code of practice for design and installation of fixed automatic high and medium velocity water spray (*first revision*)
15519 : 2020	Water mist fire protection systems — system design, installation and commissioning — Code of Practice (*first revision*)
15908 : 2021	Selection, installation and maintenance of control and indicating equipment for fire detection and alarm system — Code of Practice (*first revision*) (*under publication*)
16088 : 2012	Chlorinated polyvinyl chloride (CPVC) pipes for automatic sprinkler fire extinguishing system — Specification
16534 : 2017	Chlorinated polyvinyl chloride (CPVC) pipe fittings for automatic sprinkler fire extinguishing system — Specification
SP 7 (Part 4) : 2016	National Building Code of India 2016: Part 4 Fire and Life Safety
SP 30 : 2011	National Electrical Code (*first revision*)
SP 46 : 2003	Engineering Drawing Practice for Schools and Colleges
IS/ISO 3183 : 2012	Petroleum and natural gas industries — Steel pipe for pipeline transportation systems (*first revision*)

ANNEX B

[*Clause* 6.5 (b)]

SPECIAL GUIDELINES FOR HIGH RISE BUILDINGS

B-1 GENERAL

The requirements of this annex shall be applied to the sprinkler protection of multi-storey buildings with a height difference between the highest and lowest sprinkler exceeding 45 m.

The requirements are applicable to buildings intended for use with occupancies where the hazard is classified as no greater than ordinary hazard. Special fire engineering solutions are needed for high rise systems with hazards greater than ordinary hazard, and authorities shall be consulted for suitable advice.

B-2 DESIGN CRITERIA

B-2.1 Hazard Group

High rise sprinkler systems shall comply with the requirements as given in **B-1**.

B-2.2 Sub-division of High Rise Sprinkler Systems

High rise sprinkler systems shall be sub-divided into sprinkler installations such that the height difference between the highest and lowest sprinkler on any one installation does not exceed 45 m (*see* Fig. 18 and 19).

B-2.3 Standing Water Pressures at Non-return and Alarm Valves

a) The minimum standing pressure at any non-return or alarm valve inlet shall be no less than 1.25 times the static head difference between the valve and the highest sprinkler on the installation.

b) Non-return valves controlling installation flow shall operate correctly with a ratio of service pressure to installation pressure not exceeding 1.16 : 1, as measured by valve lift and pressure equalization upstream of the non-return valve.

B-2.4 Water Pressures

a) Pipework, fittings, valves and other equipment shall be capable of withstanding the maximum pressure likely to be encountered.

b) To overcome the problem of pressures in excess of 12 bar, hydraulic alarm gongs may be driven via a pressure reducing valve controlled by a diaphragm valve connected to the main installation control valve alarm port.

B-2.5 Pumping Requirement

It is necessary to use multi stage multi outlet pumps for high rise structures in view of the 45 m restrictions for sprinkler systems [*see* **B-1** and **B-2.6**(e)].

B-2.6 Sprinkler Installation

a) Installation shall follow various clauses from the sections concerned with respect to sprinkler selection, location, spacing, etc. Attention is also drawn to various requirements in **E-6** of SP 7 (Part 4) for sprinkler installation in high rise buildings.

b) Sprinkler installation shall be installed in the entire building throughout the building in all zones irrespective of the heights at upper zones.

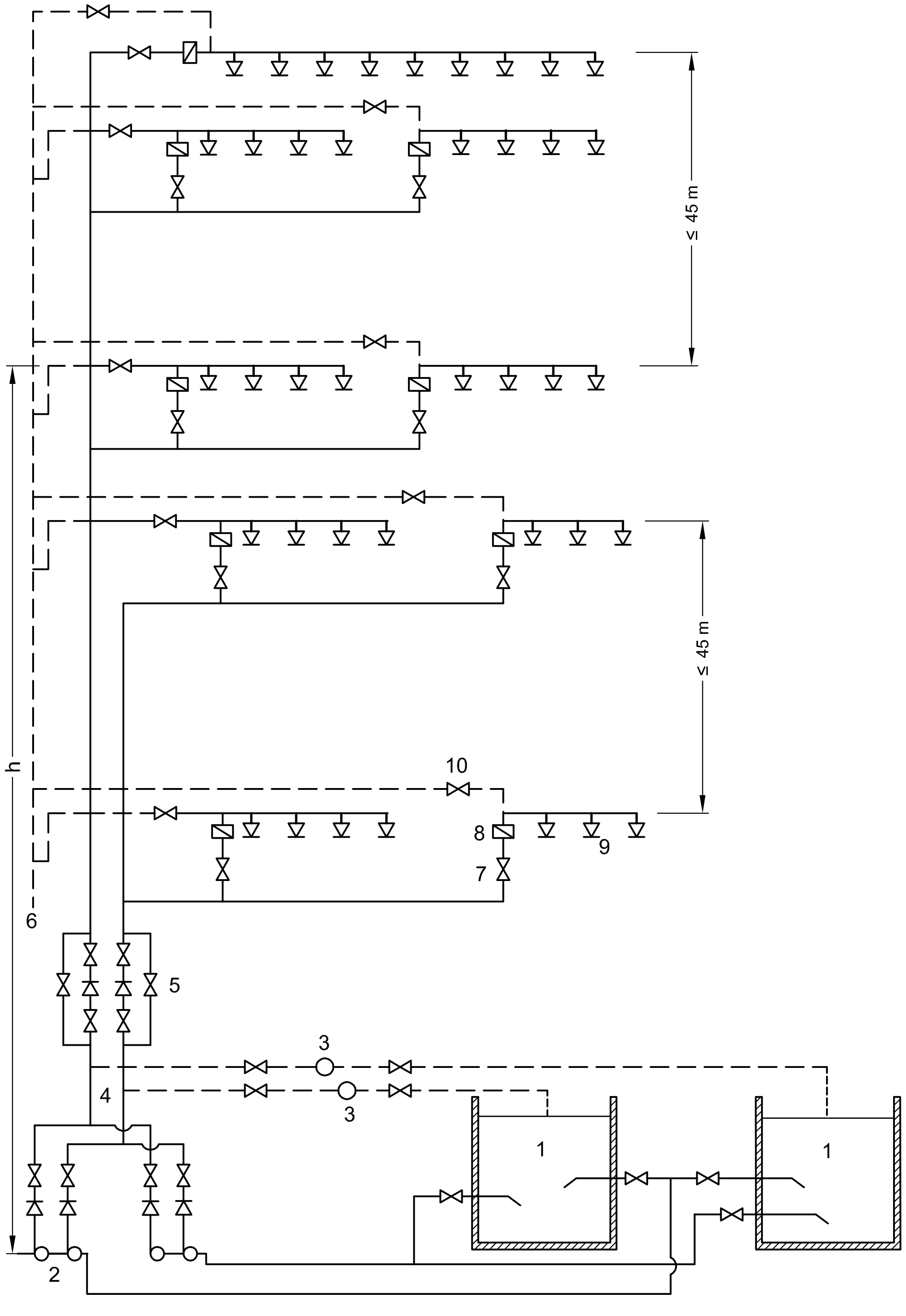
c) Apart from main sprinkler riser, standby riser(s) duly fed by separate installation control valve(s) shall also be available for each zone (*see* **9.2**).

d) A controlling valve and a water flow monitoring device shall be provided at each floor/level of high-rise buildings and the entire sprinkler installation along with floor wise components shall be provided with continuous supervisory arrangements.

e) Pressure in the sprinkler installation piping shall not exceed 7 bar and pressure at the most remote sprinkler at any level shall not be less than 0.5 bar and also not more than 5 bar. Density of application shall not be less than 5 lpm/m^2.

f) Pressure reducing valve stations shall be required to maintain allowable pressures within the installation piping everywhere (*see* **10.5.7** and **10.5.9**).

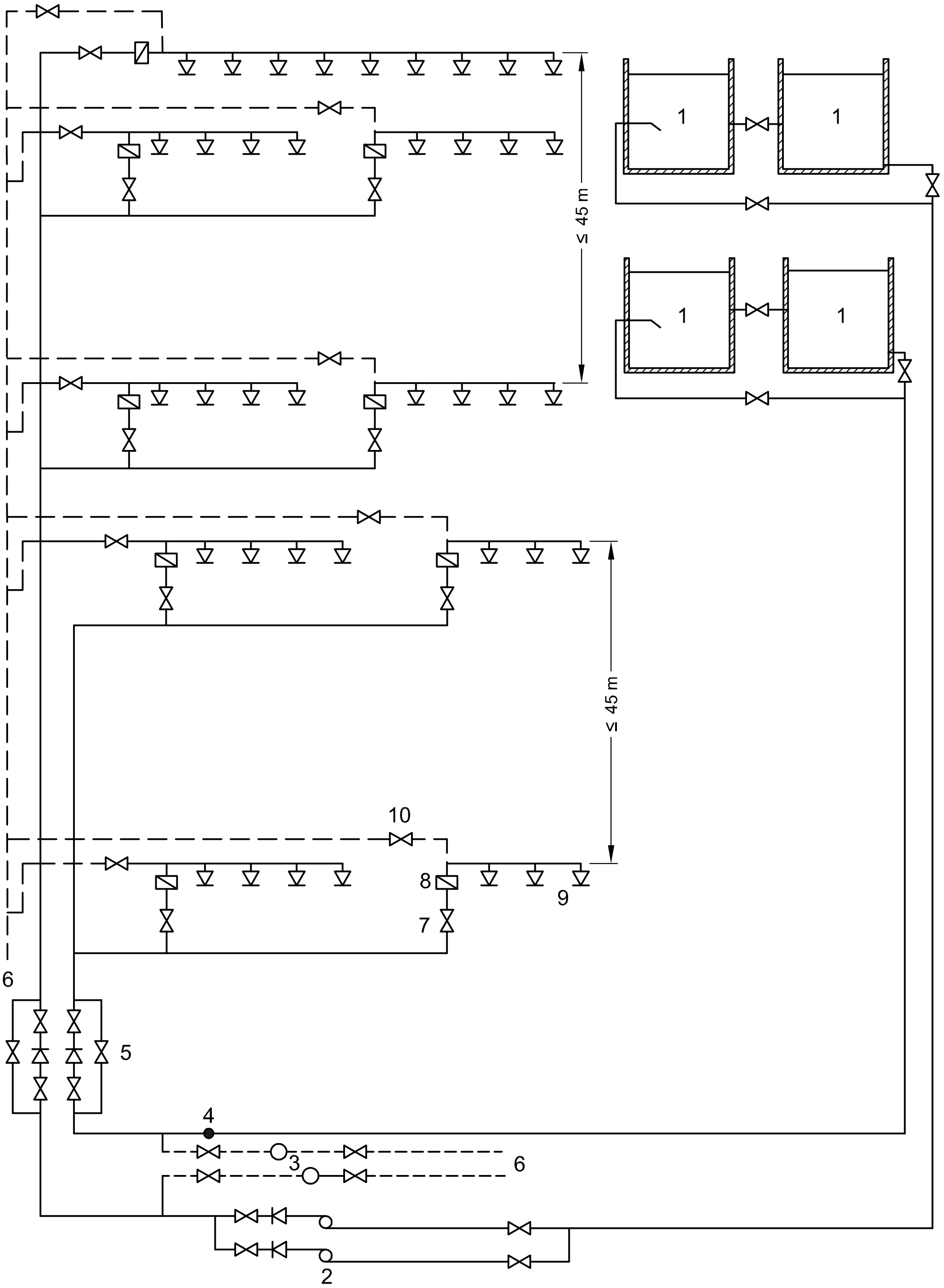
g) Software based hydraulic calculations are necessary to prove the pressures at all levels from the pumps. Where required, pressure reducing arrangements shall be made.



KEY

1 STORAGE TANK
2 MULTISTAGE PUMP
3 FLOW METER
4 WATER SUPPLY DATUM POINT
5 ALARM VALVE STATION (WITH BYPASS ARRANGEMENT)
6 FLOW TEST AND ZONE DRAINAGE
7 ZONE SUBSIDIARY STOP VALVE
8 WATER FLOW ALARM SWITCH
9 SPRINKLER HEAD
10 WATER FLOW ALARM SWITCH REST VALVE AND DRAIN VALVE

FIG. 18 SPRINKLER INSTALLATION IN HIGH RISE BUILDINGS



KEY

1	Storage Tank	6	Flow Test and Zone Drainage
2	Multistage Pump	7	Zone Subsidiary Stop Valve
3	Flow Meter	8	Water Flow Alarm Switch
4	Water Supply Datum Point	9	Sprinkler Head
5	Alarm Valve Station (with Bypass Arrangement)	10	Water Flow Alarm Switch Rest Valve and Drain Valve

Fig. 19 Sprinkler Installation in High Rise Buildings - Another Type

ANNEX C

[*Clauses* 8.1.4, 9.22.10 (c), 10.3.3 *and* 10.5.8]

GUIDELINES FOR THE PROTECTION OF STORAGE AREAS (ESFR SPRINKLER INSTALLATION)

C-0 INTRODUCTION

Early suppression fast response (ESFR) sprinklers are ceiling sprinklers which have the capability of suppressing fires within storage risks. There is little room for error in the design and installation of ESFR sprinkler systems, the design principles and the operating characteristics are significantly different from standard sprinkler protection. ESFR sprinklers might be unable to cope with adverse design features and non-compliances, which might be common practice when installing standard sprinkler protection. Design and installation deviations from this standard might not just result in a reduced effectiveness, but rather in a total system failure. It is therefore essential that all the requirements of this annex are complied with, without exception, when applying ESFR protection.

C-1 ESFR sprinkler protection, prescribed under this Annex is applicable only in case of the following:

- a) For all materials under category I through IV when stored as under (*see* Fig. 4):
  - 1) Free standing or block storage.
  - 2) Post pallets with open bottoms.
  - 3) Rack storage without solid shelving.
  - 4) Slatted open shelves.
- b) Plastic and rubber commodities when stored as under:
  - 1) Free standing or block storage; and
  - 2) Rack storage without solid shelving.

C-2 Attention is drawn to various requirements stated in **7.2.7**, **7.3**, **7.4**, **7.5**, **7.6**, **7.7** and **9.22** and the same shall taken care in designing ESFR sprinkler systems for storage buildings.

C-3 ESFR sprinklers shall not be used for the following areas:

- a) Rack storage involving solid shelves (*see* also **C-5**);
- b) Rack storage involving combustible, open-top cartons or containers;
- c) Certain materials in which fires cannot be readily controlled by sprinklers like acrylic fibre yarn or may give rise to unusual fire characteristics like tissue paper; and
- d) Buildings where automatic venting facilities are provided.

C-4 Storage methods shall have transverse and longitudinal flues as follows:

- a) Continuous for the full height of each block of storage;
- b) Vertically aligned;
- c) Free of stored goods; and
- d) Regularly spaced and having dimensions as follows:
  - 1) Transverse flues shall be at least 80 mm wide and shall be spaced at distances of not more than 3 m (*see* Fig. 10A and Fig. 10B).
  - 2) Longitudinal flues shall be at least 150 mm wide and shall be spaced at distances of not more than 3 m (*see* Fig. 10A and Fig. 10B).

C-5 Single and double row shelved racks shall comply with the following:

- a) Slatted shelves shall have shelf open areas, uniformly interspaced, of at least 50 percent of the shelf plan area. The distance between openings shall not exceed 150 mm; or
- b) Grated or mesh type shelves shall have uniform openings of at least 50 percent of the shelf plan area. The horizontal distance between openings shall not exceed 150 mm.

C-6 Sprinkler selection with regard to nominal K-factor, shank thread, temperature rating, colour coding, temperature sensitivity, etc shall be as stated in Tables 2, 3 and 4.

C-7 Spacing and location of the sprinklers shall comply with various requirements under **9.23**.

C-8 Minimum pressure at any sprinkler when all the sprinklers in the design area are in operation shall be as per the values in the Tables 32, 33, 34 and 35 (*see also* **10.5.7** and **10.5.8**).

C-9 Pipe sizing shall be done by full hydraulic calculations using an approved software program for the purpose (*see also* **10.5**).

C-10 The design area shall be a rectangular area, consist of the most hydraulically demanding area of 12 sprinklers, consisting of four sprinklers on each of the three adjoining branch lines.

C-11 Where indicated, intermediate sprinklers shall be provided as follows (*see* notes under Tables 32 and Table 34):

a) At least one level of intermediate sprinkler protection shall be installed.
b) The vertical distance from the floor to the intermediate sprinklers shall be half the rack height plus or minus half the tier height.
c) Intermediate sprinklers shall have the following properties:
    1) Spray pattern sprinkler;
    2) K-factor of 115;
    3) Quick response thermal sensitivity rating; and
    4) Temperature rating shall be within the range of 68 °C to 104 °C.
d) Intermediate sprinklers shall be located at each longitudinal and transverse flue intersection at a maximum spacing of 1.5 m in either direction;
e) Metal water shields of nominal diameter 75 mm shall be fitted above each intermediate sprinkler;
f) At least eight intermediate sprinklers shall be assumed to be operating for calculation purpose; and
g) The minimum pressure of any operating intermediate sprinkler shall be 3.5 bars.

C-12 Pumping capacity shall be calculated for the total water demand when all the 12 sprinklers at design area are in simultaneous operation and the same shall be loaded by 1 000 litre/min for hose reels and hydrants. No loading shall be required if the storage buildings are already protected by an independent and uptodate hydrant system as per IS 13039. Table 33 shall then be used to select the appropriate pump(s).

Table 32 All the Materials Stated Under Category I through IV [Post Pallets with Open Bottoms, Rack Storage Without Solid Shelving and Slatted Open Shelves]

(*Clauses* C-8 *and* C-11)

<table>
<tr><th rowspan="2">S.No</th><th rowspan="2">Maximum Storage Height
m</th><th colspan="6">Maximum Ceiling Height
m</th></tr>
<tr><th>7.6</th><th>9.1</th><th>9.7</th><th>10.7</th><th>12.2</th><th>13.7</th></tr>
<tr><td></td><td></td><td colspan="6">Minimum Operating Pressure in any Sprinkler (bar)</td></tr>
<tr><td></td><td></td><td colspan="6">K-Factor = 200</td></tr>
<tr><td>i)</td><td>6.1</td><td>3.5</td><td rowspan="2">3.5</td><td rowspan="2">4.1</td><td rowspan="3">5.2</td><td rowspan="4">5.2</td><td rowspan="5">6.2</td></tr>
<tr><td>ii)</td><td>7.6</td><td></td></tr>
<tr><td>iii)</td><td>9.1</td><td></td><td></td><td></td></tr>
<tr><td>iv)</td><td>10.6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>v)</td><td>12.2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="6">K-Factor = 242</td></tr>
<tr><td>vi)</td><td>6.1</td><td>2.4</td><td rowspan="2">2.4</td><td rowspan="2">2.9</td><td rowspan="3">3.5</td><td rowspan="4">3.5</td><td rowspan="5">4.3</td></tr>
<tr><td>vii)</td><td>7.6</td><td></td></tr>
<tr><td>viii)</td><td>9.1</td><td></td><td></td><td></td></tr>
<tr><td>ix)</td><td>10.6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>x)</td><td>12.2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="6">K-Factor = 320</td></tr>
<tr><td>xi)</td><td>6.1</td><td>1.7</td><td rowspan="2">1.7</td><td rowspan="2">2.1</td><td rowspan="3">2.4</td><td rowspan="4">3.1</td><td rowspan="5">3.5</td></tr>
<tr><td>xii)</td><td>7.6</td><td></td></tr>
<tr><td>xiii)</td><td>9.1</td><td></td><td></td><td></td></tr>
<tr><td>xiv)</td><td>10.6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>xv)</td><td>12.2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="6">K-Factor = 360</td></tr>
<tr><td>xvi)</td><td>6.1</td><td>1.4</td><td rowspan="2">1.4</td><td rowspan="2">1.7</td><td rowspan="3">2.1</td><td rowspan="4">2.7</td><td rowspan="5">3.5</td></tr>
<tr><td>xvii)</td><td>7.6</td><td></td></tr>
<tr><td>xviii)</td><td>9.1</td><td></td><td></td><td></td></tr>
<tr><td>xix)</td><td>10.6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>xx)</td><td>12.2</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

NOTES

1 This table shall not apply to pre dominant or exclusive storage of plastics and rolled paper.

2 For building heights up to 13.7 m (last column of the table), following shall apply in addition – only for sprinklers with K-Factors 200 and 242:

a) One level of in-rack sprinklers shall be considered; and
b) Not suitable for storage on post pallets with open bottoms.

3 Upright sprinkler shall be permissible based on listing for the purpose.

Table 33 All the Materials Stated Under Category I through IV [Free Standing, Palletized and Solid-Piled Storage]

(*Clauses* C-8 *and* C-12)

Sl No.	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		Minimum Operating Pressure in any Sprinkler (bar)					
		K-Factor = 200					
i)	6.1	3.5					
ii)	7.6		3.5	4.1			
iii)	9.1				5.2		
iv)	10.6					5.2	
		K-Factor = 242					
v)	6.1	2.4					
vi)	7.6		2.4	2.9			
vii)	9.1				3.5		
viii)	10.6					3.5	

Table 33 (*Concluded*)

		K-Factor = 320					
ix)	6.1	1.7	🟩	🟩	🟩	🟩	🟩
x)	7.6	🟩	1.7	🟩	🟩	🟩	🟩
xi)	9.1	🟩	🟩	🟩	2.4	🟩	🟩
xii)	10.6	🟩	🟩	🟩	🟩	2.8	2.8
xiii)	12.2	🟩	🟩	🟩	🟩	🟩	
		K-Factor = 360					
xiv)	6.1	1.0	🟩	🟩	🟩	🟩	🟩
xv)	7.6	🟩	1.0	🟩	🟩	🟩	🟩
xvi)	9.1	🟩	🟩	🟩	1.4	🟩	🟩
xvii)	10.6	🟩	🟩	🟩	🟩	1.7	2.8
xviii)	12.2	🟩	🟩	🟩	🟩	🟩	

NOTES

1 This table shall not apply to pre dominant or exclusive storage of plastics and rolled paper.

2 Upright sprinkler shall be permissible based on the listing for the purpose.

Table 34 Plastic Materials in Racks Without Solid Shelving (Un-expanded Plastic Materials Packed in Cartons)

(*Clause* C-8 *and* C-11)

Sl No.	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		Minimum Operating Pressure in any Sprinkler (bar)					
		K-Factor = 200					
i)	6.1	3.5	3.5	🟩	5.2	5.2	6.2*
ii)	7.6	🟩		4.1			
iii)	9.1	🟩	🟩	🟩			
iv)	10.7	🟩	🟩	🟩	🟩		
v)	12.2	🟩	🟩	🟩	🟩	🟩	
		K-Factor = 242					
				🟩			
vi)	6.1	2.4	2.4	🟩	3.5	3.5	4.3*
vii)	7.6	🟩		2.9			
viii)	9.1	🟩	🟩	🟩			
ix)	10.7	🟩	🟩	🟩	🟩		
x)	12.2	🟩	🟩	🟩	🟩	🟩	
		K-Factor = 320					
xi)	6.1	1.7	1.7	🟩	2.4	2.8	2.8
xii)	7.6	🟩		🟩			
xiii)	9.1	🟩	🟩	🟩			
xiv)	10.7	🟩	🟩	🟩	🟩	🟩	
xv)	12.2	🟩	🟩	🟩	🟩	🟩	
		K-Factor = 360					
xvi)	6.1	1.0	1.0	🟩	1.4	1.7	2.8
xvii)	7.6	🟩		🟩			
xviii)	9.1	🟩	🟩	🟩			
xix)	10.7	🟩	🟩	🟩	🟩		
xx)	12.2	🟩	🟩	🟩	🟩	🟩	

*At least one level of intermediate (in-rack) sprinklers shall be considered.

NOTES

1 Upright sprinkler shall be permissible based on listing for the purpose.

2 For un-expanded but exposed plastic materials (un-cartoned), above table can be applied for protection except that, sprinklers with K-factors 320 and 360 shall not be used.

Table 35 Plastic and Rubber Materials [Free Standing, Palletized and Solid-piled Storage]

(*Clause* C-8)

Sl No.	Maximum Storage Height m	Maximum Ceiling Height m					
		7.6	9.1	9.7	10.7	12.2	13.7
		Minimum Operating Pressure in Any Sprinkler (bar)					
		K-Factor = 200					
i)	6.1	3.5	3.5	🟩	5.2	5.2	🟩
ii)	7.6	🟩		4.1			🟩
iii)	9.1	🟩	🟩	🟩			🟩
iv)	10.6	🟩	🟩	🟩	🟩		🟩
		K-Factor = 242					
v)	6.1	2.4	2.4	🟩	3.5	3.5	🟩
vi)	7.6	🟩		2.9			🟩
vii)	9.1	🟩	🟩	🟩			🟩
viii)	10.6	🟩	🟩	🟩	🟩		🟩
		K-Factor = 320					
ix)	6.1	1.7	1.7	🟩	2.4	2.8	2.8
x)	7.6	🟩		🟩			
xi)	9.1	🟩	🟩	🟩			
xii)	10.6	🟩	🟩	🟩	🟩		
xiii)	12.2	🟩	🟩	🟩	🟩	🟩	
		K-Factor = 360					
xiv)	6.1	1.0	1.0	🟩	1.4	1.7	2.8
xv)	7.6	🟩		🟩			
xvi)	9.1	🟩	🟩	🟩			
xvii)	10.6	🟩	🟩	🟩	🟩		
xviii)	12.2	🟩	🟩	🟩	🟩	🟩	

NOTES

1 This table shall apply to un expanded plastics packed in cartons.

2 Upright sprinkler shall be permissible based on the listing for the purpose.

3 For un-expanded but exposed plastic materials (un-cartoned), above table can be applied for protection except that sprinklers with K-factors 320 and 360 shall not be used.

ANNEX D

(*Clause* 9.24.3)

PRE-ACTION SPRINKLER SYSTEMS

D-0 GENERAL

Pre-action installations shall be one of the following types:

a) *Non-interlock Sprinkler Systems* — This is an otherwise normal dry pipe installation in which the control valve set is activated either by an automatic fire detection system or by the operation of the sprinklers. Independently of the response of the detectors a pressure drop in the pipework causes the opening of the alarm valve. These systems installations are only recommended in areas where fore spread is expected to be rapid.

b) *Single-interlock Sprinkler Systems* — This is an otherwise normal dry pipe installation in which the control valve set is activated by an automatic fire detection system but not by the operation of the sprinklers. These systems installations are only recommended in areas where considerable damage could occur if there was an accidental discharge of water.

c) *Double-interlock Sprinkler Systems* — This is an otherwise normal dry pipe installation which admits water to sprinkler piping upon operation of both detection devices and automatic sprinklers. When used to protect areas that are subject to freezing, double-interlock sprinkler systems shall be installed.

Pre-action sprinkler systems are acceptable for installation when the ambient temperature of the protected area is above –7 °C at all times. Components like pre-action valve, solenoid valve, automatic-release panel combination along with chosen detection system shall have approval from national/international agencies.

D-1 INSTALLATION REQUIREMENTS

a) Sprinklers shall be installed as specified by the supplier or as stipulated in **9.17** where applicable.

b) Piping for range pipes shall be pitched at least 4 mm/m and distribution piping shall be pitched 2 mm/m.

c) Gridded layouts are not permitted for double interlock pre-action systems and also for pre-action systems protecting storage occupancies.

d) A system size for double interlock pre-action systems of not more than 1 000 shall be permitted.

e) The air/inert gas pressure in the installation shall be monitored at all times. At least one quick opening manually operated valve shall be installed in an appropriate position to enable the pre-action valve to be activated in an emergency.

f) In the event of a fault in the fire detection system, the installation shall operate as an ordinary dry pipe system.

D-2 SIZE OF INSTALLATIONS

The number of sprinklers controlled by a pre-action alarm valve shall not exceed that shown **9.2** that is, number of sprinkler heads in the given area.

D-3 PIPING ARRANGEMENT

D-3.1 Sprinkler piping for single-interlock pre-action sprinkler system shall be arranged as follows:

a) To provide single-path flow (no loops) within all parts of the sprinkler system.

b) To meet the recommendations area of coverage as in **8**.

EXCEPTION — The feed main or cross main of a single-interlock pre-action sprinkler system protecting a non-storage occupancy can be looped as opposed to single-path flow, but must still meet area of coverage as in **8.1**.

D-3.2 Sprinkler piping of a non-interlock or double-interlock pre-action sprinkler system shall be arranged as follows:

a) To provide single-path flow (no loops) within all parts of the sprinkler system;

b) To meet the recommendations area of coverage as in **8**; and

c) To meet the maximum recommended water delivery time once the first sprinkler has operated.

EXCEPTION — The feed main or cross main of a non-interlock or double-interlock pre-action sprinkler system protecting a non-storage occupancy can be looped as opposed to single-path flow, but must still meet the other two criteria listed above.

D-4 SPRINKLER SYSTEMS WITH MORE THAN ONE PRE-ACTION INSTALLATION

Where a sprinkler system includes more than one pre-action sprinkler installation, a risk assessment shall be undertaken to establish whether simultaneous operation of more than one pre-action installation could occur. Where simultaneous charging of pre-action sprinkler installations might occur, the following shall be implemented:

a) The volume of stored water supplies shall be increased by the volume of the total pre-action installations.

b) The time between multiple pre-action installations tripping and water discharging from any remote test valve on the installations under consideration shall not exceed 60 s.

D-5 GAS SUPPLY FOR PRE-ACTION SPRINKLER SYSTEMS

a) Provide the gas supply for a pre-action sprinkler system in accordance with the following recommendations for dry-pipe sprinkler systems.

b) The gas used for maintaining internal pressure within the dry-pipe sprinkler system can be dry air, an inert gas, or any other gas approved specifically for this application. It shall be ensured that the gas used in the dry-pipe sprinkler system is compatible with all sprinkler system components.

c) Gas supply shall be so arranged to ensure availability at all times for the dry-pipe sprinkler system in accordance with the dry-pipe valve manufacturer's specifications.

d) Ensure the gas supply maintained on site is reliable; and is capable of filling the dry-pipe automatic system up to the minimum required system maintenance pressure within 30 min, but is also arranged to:

    1) Allow the dry-pipe sprinkler system to meet the maximum recommended water delivery time as specified in the manual for different occupancy classifications.

    2) Not exceed the maximum recommended gas pressure maintained in the pre-action sprinkler system.

e) A check valve shall be installed on the connection between the gas supply and the pre-action sprinkler system.

f) Also a relief valve shall be installed between the gas supply and the pre-action sprinkler system arranged to relieve at 0.3 bar above the maximum recommended gas pressure maintained within the system.

D-6 AUTOMATIC DETECTION SYSTEM

a) The detection system shall be installed in all rooms and compartments protected by the pre-action sprinkler system and shall be in accordance with IS 2189 in all respects.

b) Fire alarm panels shall also be installed in the vicinity and the same shall be in accordance with IS 15908 in all respects.

c) Where heat detectors are installed, activation temperature of the detectors shall be lower than the same for sprinklers.

d) Detectors shall be electric or pneumatic fixed temperature type with temperature ratings less than that of the sprinklers as mentioned above. No detectors shall be of rate-of rise type.

ANNEX E

(*Informative*)

(*Foreword*)

SPRINKLER PROTECTION FOR COLD STORAGE OCCUPANCIES

E-1 The requirements of this annex shall be applied to the sprinkler protection of cold storage and warehouses. The requirements prescribed in this annex provide for dry pipe, pre-action and dry sprinklers used in otherwise wet pipe sprinkler systems.

E-2 GENERAL REQUIREMENTS

a) Automatic provisions shall be available to shut down the air circulation system within the cold storage area, when detection system or sprinkler operates.

b) Where sprinkler elements are likely to be damaged by mechanical impact during loading/unloading operations, they shall be protected against such damage by providing metallic guards.

E-3 INSTALLATION REQUIREMENTS

a) Pipelines shall be above ground and readily accessible. It shall be possible to dismantle the pipes at short notice.

b) To enable quick removal of pipes, grooved or flanged joints shall be used as they are the best option.

c) Pipe supports shall also be so designed to enable removal of pipes with slight efforts.

d) Wherever turning is necessitated for the pipes within the cold storage area, 'T' joint shall be used and another end of 'T' shall be sealed. This is required for inspection purpose to check whether any ice formation has taken place.

e) Provisions shall be available to purge the pipe lines after an operation to ensure all moisture contents are removed.

E-4 PRESSURIZATION OF PIPELINES

a) Pipework downstream of installation valve shall be pressurized either with dry nitrogen gas or air drawn across the freezers of lowest temperature in the plant and through a dehydrator.

b) Where nitrogen gas is used, due care shall be taken to see that any accidental leakage shall not result in asphyxiation for personnel around.

c) Pressure reducing valves shall be installed on the nitrogen cylinders to control the pressure. Also pressure relief valves shall be fitted to operate at the upper limit of the required gas installation pressure.

E-5 PERFORMANCE REQUIREMENTS

a) Minimum time between sprinkler operation and water discharge shall not exceed 30 s for high hazard storage and 60 s for ordinary hazard storage.

b) Suitable calculations shall be made at the design stage to ensure efficient water discharge based on the above timing.

E-6 OTHER REQUIREMENTS

a) Dry sprinklers should be inspected at regular intervals for ice build-up or signs of ice formation in the sprinkler rise or drop pipe. Visual inspections shall take place at least annually.

b) Water and water vapour ingress into a dry ‘drop’ sprinkler should be avoided.

c) Any water ingress into the sprinkler pipe will freeze, resulting in ice build-up. Ice build-up may seriously impair sprinkler performance and may prevent sprinkler operation or cause obstructions to the water flow.

d) Where ice build-up occurs or if ice extrudes through any drain aperture in the sprinkler heat-sensitive element support, the dry sprinkler assembly should be removed and replaced.

e) Hydraulic calculations shall consider friction losses/gains through drop/riser pipes within the cold storage. Friction losses within the drop/riser pipes may however be ignored.

f) The length of the drop or rise pipe on a dry sprinkler within the heated area shall be of sufficient length to prevent freezing at the wet pipe end due to conduction of heat to the cold store. The minimum length for the drop pipe shall be determined using:

$$L = -0.0137\ (T_c + 6.67)$$

where

L = minimum length of the drop pipe (in m), within the heated area, that is, drop pipe length exposed in heated area. It should not include the length covered by cold store ceiling insulation or exposed to cold store temperatures.

T_c = minimum temperature of cold store, in °C.

ANNEX F

(*Informative*)

(*Foreword*)

ZONING OF SPRINKLER INSTALLATION

F-1 GENERAL

This annex specifies requirements particular to the sprinkler protection of buildings when zoning is adopted. It applies only to OH sprinkler installations of the wet pipe type. This annex is only for technical information and is optional.

F-2 ZONING CONCEPT

a) The protected floor area to be controlled by any one installation alarm valve on any one floor shall not exceed 12 000 m^2 (*see* **9.2**).

b) Car parks and areas involving the unloading and storage of goods shall be on a separate unzoned installation.

c) Building concerned shall be fully sprinkler protected to enable zoning.

d) The protected floor area to be controlled by any one installation alarm valve shall not exceed 12 000 m^2.

F-3 ZONING REQUIREMENTS

a) The protected floor area per zone shall not exceed 6 000 m^2.

b) Each zone shall be independently controlled by a single zone subsidiary stop valve, installed in a readily accessible position at the floor level of the zone it controls. Each valve shall be secured open and be labelled to identify the area of protection it controls.

c) Each zone shall be fitted with a flushing valve no less than 20 mm nominal diameter, either on the end of the distribution pipe hydraulically most remote from the water supply, or on the end of each distribution pipe spur, as appropriate. The valve outlet shall be fitted with a brass plug cap.

d) Permanent test and drainage facilities for the zones shall be provided immediately downstream of the water flow alarm switch on each zone. The test facility shall simulate operation of any single sprinkler head. Adequate provision shall be made for the disposal of waste water.

e) The installation alarm valve of a zoned sprinkler installation shall have two stop valves, one on each side of a single alarm valve with a bypass connection of the same nominal bore around all three valves, fitted with a normally closed stop valve (*see* Fig. 20). Each of the three stop valves shall be fitted with tamper proof devices to monitor their status.

F-4 MONITORING OF THE INSTALLATION

a) Zoned sprinkler installations shall be provided with tamper-proof devices to monitor the status of:

   1) Each stop valve (that is either fully open or not fully open), including subsidiary stop valves, capable of interrupting the flow of water to sprinklers.

   2) Water flow into each zone immediately downstream of each zone subsidiary stop valve, to indicate the operation of each zone, by means of a water flow alarm switch capable of detecting a flow equal to or greater than that from any single sprinkler.

   3) Water flow through each main installation alarm valve set.

b) The monitoring devices required by **F-4** (a) and **F-3** (e) shall be electrically connected to a control and indicating panel, installed at an accessible location on the premises, where the following indications and warnings shall be given:

   1) Green visual indicators to indicate that each monitored stop valve is in its correct operational position.

   2) Audible devices and amber visual indicators to indicate that one or more control valve sets are not fully open.

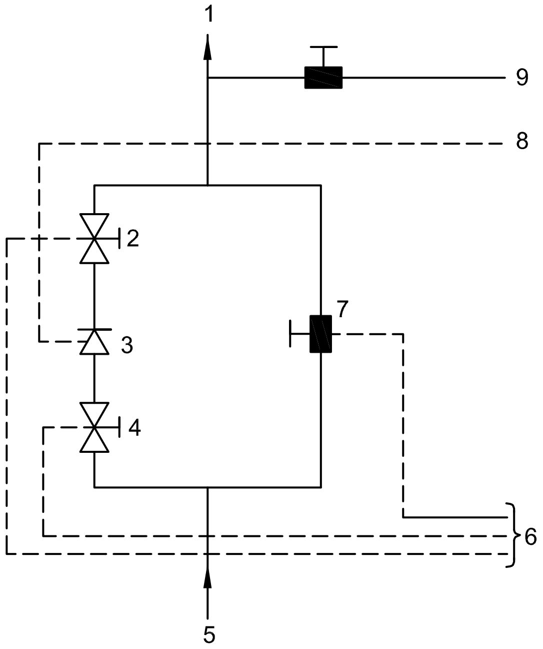
   3) Audible devices and amber visual indicators to indicate that one or more zone subsidiary stop valves are not fully open.

   4) Audible devices and amber visual indicators to indicate that the static pressure in any trunk main supplying the system has fallen to a value 0.5 bar or more below the normal static pressure.

   5) Audible devices and red visual indicators to indicate that water is flowing into the installation.

F-5 DRAWINGS

For all installation which are cut into zones, full detailed block plan shall be prepared to exhibit the positions of all zone control valves.



KEY

1 TO INSTALLATION
2 DOWNSTREAM STOP VALVE
3 ALARM VALVES
4 UPSTREAM STOP VALVE
5 FROM WATER SUPPLY
6 INSTALLATION MONITORING FACILITY
7 BYPASS STOP VALVE
8 ALARM DEVICES
9 ALARM TEST CONNECTION

FIG. 20 CONTROL VALVE BYPASS ARRANGEMENT FOR ZONED BUILDING INSTALLATIONS

ANNEX G

(*Informative*)

(*Foreword*)

SPRINKLER INSTALLATION — SUPERVISION

G-1 GENERAL

a) The aim of supervising sprinkler systems is the continuous monitor of the main functions of the system, that is, those whose failure might impair the correct automatic operation of the system in case of fire, and the raising of a supervisory alarm to allow corrective measures to be taken. This annex specifies requirements, which are additional to that elsewhere in the standard. They shall be complied with whenever monitoring is specified.

b) All devices used for monitoring shall have at least IP 54 protection as specified in relevant Indian Standard. No more than 15 non-addressable supervisory alarm devices shall be connected to a common indication.

c) All signalling and alarm circuits shall be fully supervised and a fault alarm shall be given in the event of short or open circuit where this corresponds to a fault.

d) Control and indicating equipment shall be in accordance IS 2189.

e) If no fire alarm system is provided, then main control panel of sprinkler pump in fire pump room shall be provided with facilities listed in this Annex.

G-2 SUPERVISORY FUNCTIONS

a) The position of all normally open stop valves the closing of which could prevent water flowing to the sprinklers, including water supply valves, control valve sets, subsidiary valves and sectional valves. An indication shall be given whenever the valve is less than fully open.

b) The position of all normally open stop valves the closing of which could prevent the correct operation of an alarm or indicating device, for example, pressure switch, hydraulic alarm, flow switch. An indication shall be given whenever the valve is less than fully open.

c) All critical liquid levels, including water storage tanks and engine fuel tanks. An indication shall be given before a water storage level drops more than 10 percent below its nominal fill level, or before a fuel level drops more than 25 percent below its nominal fill level. In the case of pressure tanks a further indication shall be given before the level reaches 10 percent above its nominal fill level.

d) Pressures, including at water supplies and downstream of all dry and alternate control valve sets. On town main supplies and indication shall be given if the static pressure drops below the calculated running pressure. In all other cases an indication shall be given when the static pressure drops by more than 20 percent below the tested level.

e) The power supply to electrical pump sets or other critical electrical equipment. An indication shall be given if one or more phases fail at any point in the main supply, or in the control circuit or an electric or diesel pump controller or any other critical control equipment.

f) Minimum temperature of the sprinkler valve and pump room. An indication shall be given if the temperature drops below the minimum required level.

ANNEX H

(*Foreword*)

COMMITTEE COMPOSITION

Fire Fighting Sectional Committee, CED 22

Organization	*Representative(s)*
Ministry of Home Affairs, New Delhi	Shri D. K. Shami (***Chairman***)
Agni Controls, Chennai	Shri D. Balachandran Shri Arun Kumar Balachandran (*Alternate*)
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Directorate of Fire and Emergency Services, Goa	Shri Ashok Menon Shri Nitin V. Raiker (*Alternate*)
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Member Secretary

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CSIR-Central Building Research Institute, Roorkee	Shri Rajiv Goel Shri R. S. Chimote (*Alternate*)
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Ministry of Home Affairs, New Delhi	Shri D. K. Shami

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(*Continued from second cover*)

- h) Inclusion of use of CPVC pipes for installation of automatic fire sprinkler extinguishing system; and flexible sprinkler pipes have also been included.
- j) Certain new components have been introduced under sprinkler hardware like new types of supports and other auxiliaries.
- k) More illustrations have been introduced to enhance clarity.

Informatory Annexes E, F and G have been included on protection of cold storage facilities; zoning of sprinkler installation; and supervision of sprinkler installation respectively.

The guidelines contained in this standard are intended to be used with judgment in determining the protection requirements. The classification of various commodities, their class with respect to the overall hazard which is expressed as a function of its heat release rate (Btu/min or kW) which is the product of its heat of combustion (Btu/lb or kJ/kg) and burning rate (lb/min or kg/s) are also covered herein.

Nothing in this standard prevents introduction of new concepts and technologies, when such systems are at least equivalent or superior to various provisions of this standard; and backed up by successful full-scale fire testing in recognized test laboratories where the design criteria and test results have been fully documented.

The composition of the Committee responsible for the formulation of this standard is given in Annex H.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value observed of calculated, expressing the result of the test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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